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AERONAUTICAL ENGINEERING REVIEW

AUGUST 1946

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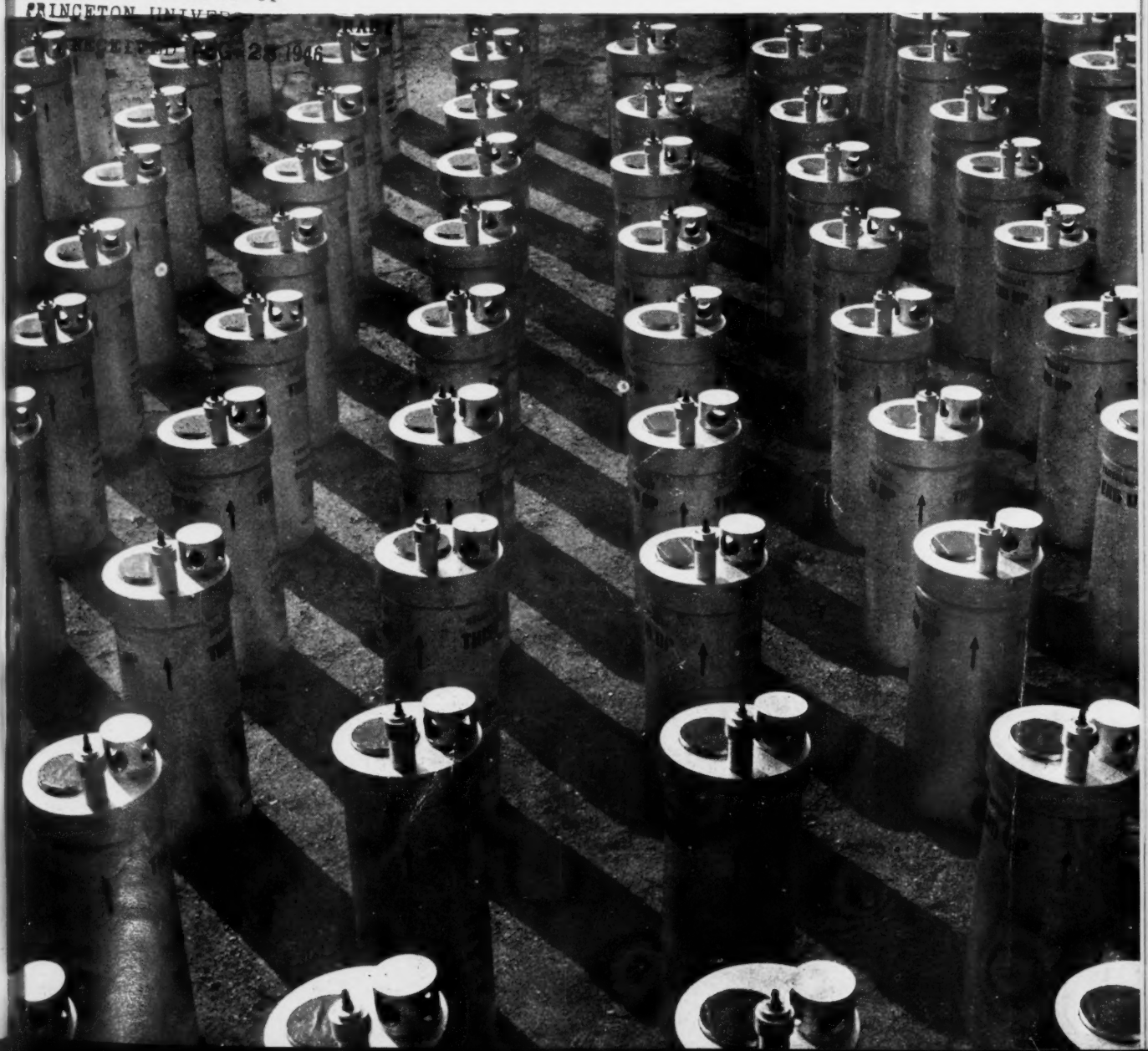

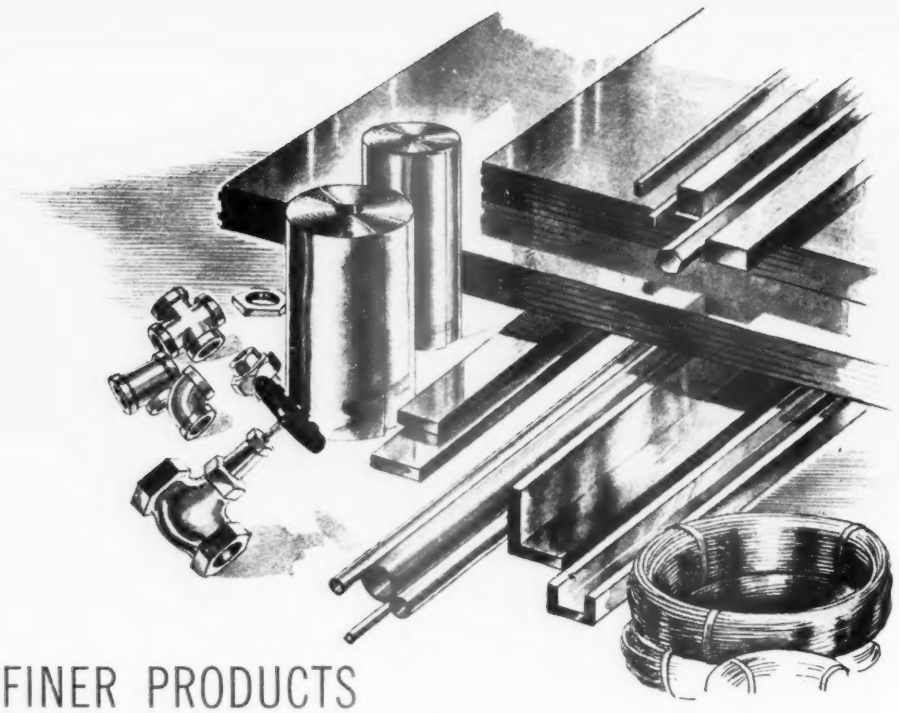

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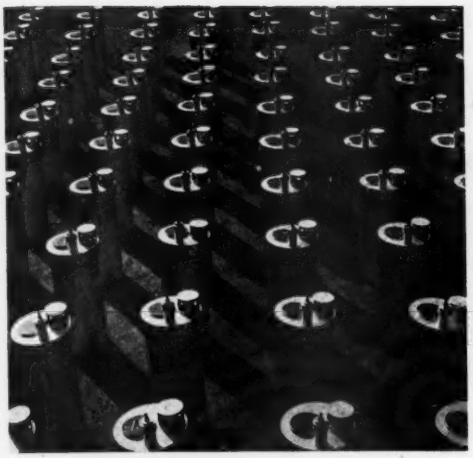

Cover—Two-hundred-pound thrust, 8-sec. duration Jato motors for U.S. Navy

AERONAUTICAL ENGINEERING REVIEW

Vol. 5 August, 1946 No. 8

Contents

I.A.S. News 5
Editorial 17

Articles

Personal Plane Problems . . . . . Ralph Upson 18
The Pilot and the Controls. Wolfgang Langewiesche 25
Simplified Design for Personal Plane Engines . . . . . Carl T. Doman 29
Exhaust Pump for Engine Cooling. Carl de Ganahl 34

Reviews

Periodicals 39
Government Publications 61
Books 71

The Aircraft Year Book for 1946 — From Balloon to Bomber
Understanding Microwaves — Mathematical Theory of Elasticity
Designing with Magnesium

Industry Publications 75

Personnel Opportunities 89
Index to Advertisers 97

Published Monthly by the Institute of the Aeronautical Sciences, Inc.

Editor
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SUBSCRIPTION RATES

Aeronautical Engineering Review: United States and possessions, 1 year, $3.00; single copies $0.30. Foreign countries including Canada (American Currency Rates), 1 year, $3.50; single copies, $0.35.

Entered as second-class matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 2 East 64th Street, New York 21, N.Y.

Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

Statements and opinions expressed in the *Aeronautical Engineering Review* are to be understood as individual expressions and not those of the Institute.

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PAN AMERICAN WORLD AIRWAYS

Uses

VICKERS

HYDRAULIC EQUIPMENT
ON ITS
LOCKHEED CONSTELLATION CLIPPERS

The Lockheed Constellation Clippers recently accepted by Pan American World Airways for its New York to London Service use Vickers Hydraulic Equipment.

The Vickers Variable Volume Piston Type Pump automatically delivers the volume of fluid required by the main hydraulic system . . . at all times with minimum horsepower. Maximum operating pressure of this installation is 1750 psi. Vickers Hydraulic Motors are used for wing flap operation because of their high starting and running torque. Also, they can be stopped accurately to position, started instantly and stopped instantly due to the very low inertia of their moving parts. Their horsepower weight ratio is exceptionally high. The Vickers Relief Valve, Unloading Valve and Accumulator are used in the auxiliary flight control booster system.

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I.A.S. News

A Record of People and Events of Interest to Institute Members

Whittle Lecture Series Inaugurated in New York

Inventor of first successful British jet engine addresses I.A.S. audiences in New York, Philadelphia, and Buffalo

Air Commodore Frank Whittle, Technical Adviser on Engine Design and Production to the Controller of Supplies at the Ministry of Supply (Air), addressed a special meeting of the New York Section of the Institute on Thursday evening, June 27, on the subject of "The Advent of Aircraft Gas Turbines." Commodore Whittle arrived in this country June 18 for a series of lectures and will return to England in the fall.

The meeting was held at the McMillin Theatre of Columbia University in New York, and 400 members and guests of the Institute attended. Captain S. Paul Johnston, Director of the Institute, acted as Chairman. Professor George B. Pegram (Hon. M.I.A.S.), of the Physics Department of Columbia University, and Sir Roy Fedden (Hon. F.I.A.S.), Past-President of The Royal Aeronautical Society, spoke briefly. Sir Roy stressed the necessity for close collaboration between the United States and England and expressed a desire for increased interchange of ideas and closer personal contact between the members of the two societies. Major Gardner, Chairman of the Council of the Institute, and an Honorary Fellow of The Royal Aeronautical Society, heartily endorsed Sir Roy's suggestion of regular visits between the members of the I.A.S. and R.Ae.S.

Commodore Whittle outlined the history of the new method of propulsion and described the steps leading up to the development of present-day jet power plants. The first Whittle engine was successfully tested on April 12, 1937, but it was not until the outbreak of war in 1939 that the government (British) showed interest. When the Ministry took over his organization, Whittle gave his rights on the engine to the government. The first flight of an aircraft powered with the engine took place in 1941.

Air Commodore Frank Whittle.

A color film was shown explaining the development of the engine from the early days of Power Jets, Limited, to the time of the formation of the first squadron of jet-propelled airplanes. Slides were shown to illustrate Commodore Whittle's presentation of problems of air density and temperature and to show various types of jet engines. He stated that if a long range were desired it was necessary to fly at extremely high altitudes. He expressed his belief that pilots would never fly in planes equipped with ram jet engines, but that this type of power would be used in connection with projectiles or as a supplementary source of power for the turbojet engine.

Commodore Whittle predicted that a "jet era" was 5 years away and that the increased speed of the jet plane, together with a tremendous saving in weight, would outmode planes powered by reciprocating engines, with the exception of light planes. For achieving speeds up to 300 m.p.h., the gas-turbine-driven propeller would be used; for speeds from 350 to 500 m.p.h., a gas-turbine-driven ducted jet would be employed; and for speeds above 500 m.p.h., the "pure" jet would be used. He believes that the British lead the world in jet engine development but that the United States is ahead in airframe development. The German jet planes were not particularly advanced, since the Germans suffered greatly from lack of materials that would withstand the temperature developed by their jet power plants.

Following the lecture, Commodore Whittle answered questions from the audience.

Air Commodore Whittle repeated his lecture before the I.A.S. Philadelphia Section on July 2 (*see* page 10) and the Buffalo Section on July 8.

I.A.S. Calendar

October 24, 1946	Air Transport Meeting, Hotel Statler, Washington, D.C.
December 17, 1946	Tenth Wright Brothers Lecture, New York, N.Y.
January 28–30, 1947	Fifteenth Annual Meeting, New York, N.Y.

For further details see page 15.

The Past Predicts the Future

Title of General Arnold's dinner address sounded the keynote of I.A.S. Annual Summer Meeting at Los Angeles. Relaxing of restrictions put presentation and discussion of technical papers on a prewar basis. Large attendance registered from all over the United States.

NOT SINCE THE DAWN of mechanical flight has the immediate future held such a challenge for aeronautical engineers as exists today. Everyone who attended the technical sessions of the Annual Summer Meeting of the Institute came away with a feeling that old limitations had been by-passed—that there were few boundaries to the fields of the Aeronautical Sciences that could not eventually be hurdled.

It was particularly appropriate that the wartime head of the Army Air Forces should make the final address of the meeting. For the two days preceding, U.C.L.A.'s Royce Hall had echoed with facts, formulas, and figures as the country's top aeronautical engineers blueprinted the future of aircraft design and construction. General Arnold provided the inspirational touch that added the warmth of enthusiasm to the presentation of cold facts.

Addressing some 500 Institute members and guests in the Embassy Room of the Los Angeles Ambassador Hotel on the evening of July 19, he pointed out the close connection that had been established during the war between civilian engineers and scientists and the Army Air Forces. He stressed that the future security of the nation and the world required that this cooperation be continued and improved in the years ahead, unless the people want to face another world war. In such a war the United States would not be the arsenal of democracy, but the *battlefield*. We must preserve our leadership in aviation in order to back with all of our might a world ruled by law and not by force. Because of the conquest of space during World War II, our geographical location will no longer furnish us the time to build a military machine. The development of atomic and biological warfare threatens the importance of our vast national resources and our great industrial capacity. Only a strong America, driving with determination toward its goal of world peace, can lead other nations through this dangerous interim period.

General Arnold stressed the essential role the aeronautical sciences will play in the drive toward peace and underlined the principle that cooperation between civilian and military personnel must be of the highest possible order. The Army Air Forces has recognized the importance of such collaboration to the future development of air power by establishing a research and development office on the highest staff level and by working closely with advisory panels of scientists and aeronautical companies. The War Department has established a Director of Research and Development on a par with other general staff directors. In other words, the armed services have laid the foundation for a thorough integration of civilian and military technical resources, and it is now the obligation of the civilians to answer the new call for duty.

Above all, we need inspired leadership and disciplined and trained minds, or the end result of all of our activities will be wasteful mediocrity.

Of particular interest to the I.A.S. group was the importance placed by General Arnold on the selection and training of men with special aptitudes and outstanding ability and encouraging them to develop their talents to the fullest. The Army Air Forces is establishing special education institutions, such as the Air University, and is encouraging its officers to acquire special professional training in civilian institutions. We need men who can not only develop new devices but who can visualize the implications of these devices on human welfare. We must be thinking not only of the technical development of jet, ram-jet, and rocket propulsion and of transport beyond the atmosphere but also of the social and military implications that the solution of the spaceship problem would entail.

Gen. H. H. Arnold—Dinner Speaker.

In conclusion, General Arnold pointed out that all such activities will not only contribute to the military security of the nation but will also further the progress of civil aviation. There is no sharp borderline between civilian and military interests in aviation. A strong and progressive civilian aviation in-

dustry is the first requirement for the defense in the United States. With its support the Army Air Forces will be able to meet any challenge.

Preceding the dinner meeting General and Mrs. Arnold were the guests of the Institute at a reception attended by many notable figures in aviation. I.A.S. President, Arthur Raymond of Douglas Aircraft, was host at the reception and presided as toastmaster at the dinner. Seated at the Speaker's table with General Arnold and Mr. Raymond were: I.A.S. Past-Presidents—Clark B. Millikan, Reuben Fleet, and Charles Colvin; Major Gen. E. M. Powers, A.A.F.; Col. Emile T. Kennedy, A.A.F.; Capt. C. M. Huntington, U.S. Navy; S. Paul Johnston, Director I.A.S.

Registration for the meeting got under way at Royce Hall on the morning of July 18. Over 700 members and guests registered for the meeting, and a check of the attendance list indicated that approximately 25 per cent of those who registered came from outside the Los Angeles area. After a brief address of welcome by Dean Boelter and a word of greeting from headquarters by Paul Johnston, Chairman John F. Parsons, Assistant Engineer-in-Charge of the N.A.C.A.'s Ames Laboratory called the first technical session to order—Subject: Flight Testing.

Two papers were presented: the first on "Flying Qualities Requirements for Military Aircraft" by Lt. Malcolm J. Abzug, U.S.N.R., Bureau of Aeronautics, Navy Department; the second on "Why Flight Test?" by Albert C. Reed, Aviation Consultant. Lieutenant Abzug covered some of the newer and more exacting requirements that must be met by designers as a result of wartime experiences and developments. Mr. Reed raised some fundamental questions on what might be called the philosophical approach to the problem of flight test, asking why we should bother to undertake something that costs so much in time, money, and lives.

C. L. "Kelly" Johnson,
Los Angeles Section Chairman.

I.A.S. President, Arthur Raymond,
Toastmaster at the Dinner.

A new flight-test technique, free flight research by radio-controlled aircraft, was described in Bell Aircraft Company's color film *Planes Without Pilots*. Running comment on the film was given by R. M. Stanley, Chief Engineer, and R. H. Frost, Project Engineer, both of Bell Aircraft.

The afternoon session on Aerodynamics, under the able guidance of Dr. Clark B. Millikan, Acting Director of the Guggenheim Aeronautical Laboratory of California Institute of Technology, went into more theoretical realms. Three subjects of great current interest were discussed: "Interaction of Boundary Layer and Shock Waves in Transonic Flow," by Hans W. Liepmann, of C.I.T.; "Jet Aircraft Utilizing Boundary Layer Air for Propulsion," by A. M. O. Smith and H. E. Roberts, of Douglas Aircraft, El Segundo; and "Development of Rational Tail Load Criteria," by L. A. Clousing, Ames Laboratory, N.A.C.A.

In the evening, under the chairmanship of Edward Schmued, of North American, the trend was less theoretical with detailed discussion of the engineering of the Rainbow by Alexander Kartveli, of Republic Aviation Corporation, and an account of the design and development of the XB-42 by Carlos Wood, of Douglas Aircraft, Santa Monica. Both papers had a strong appeal to the engineering-minded in the audience. As the finale for the day, Col. H. M. McCoy, Chief of the Air Documents Division of Intelligence, A.A.F., Wright Field, described the collection of technical material from the German aircraft builders and told how such information is being made available to the United States aircraft industry.

The afternoon session on Friday, July 19, employed the "Information Please" or "Quiz Kids" technique, in which a panel of experts conducted a Symposium on "Fatigue Phenomena in Aircraft"—with audience participation. Charles R. Strang, of Douglas Aircraft, Santa Monica, acted as the strong arm that kept the participants from tearing each other limb from limb. Official participants in the technological "Battle Royal" were: L. R. Jackson, Battelle Memorial Institute; J. F. McBrearty, Lockheed Aircraft; M. A. Miner, Douglas Aircraft; R. L. Schleicher, North American Aviation; George Snyder, Boeing Aircraft; and R. V. Rhode, N.A.C.A.

Jet and turbojet problems filled the agenda for the last session on Friday afternoon, with William Bollay, of North American Aviation, in the chair. It is to be regretted that the announced paper on rocket motors by Norton B. Moore, of Aerojet Engineering Corporation, had to be withdrawn at the last moment because of security reasons. It was one of those *contre-temps* that must occasionally be faced under current conditions. The Navy simply said "No," and meant it. The remaining two papers, however, one on the "Development of Major Components for Aviation Gas Turbines" by A. H. Redding, of Westinghouse, and the other on "Increasing Performance of the Turbo Jet," by N. C. Price, of Menasco Manufacturing Company, provided nourishing fare for the attendees.

Subsequent issues of the REVIEW and the JOURNAL OF THE AERONAUTICAL SCIENCES will carry in full a number of the papers from the Summer Annual Meeting. A future issue of the REVIEW will contain an analysis of the principal papers and a report on the discussions that followed.

Program Committee Chairman,
L. E. "Gene" Root.

Th. von Kármán to Give 1946 Wright Brothers Lecture

Dr. Th. von Kármán, Director of the Guggenheim Aeronautics Laboratory at the California Institute of Technology and an Honorary Fellow of the Institute, will deliver the Wright Brothers Lecture for 1946. The Lecture, titled "Supersonic Aerodynamics—Principles and Applications," will be given on December 17 in New York City.

Dr. von Kármán received the degree of Mechanical Engineer at the Royal Technical University, Budapest, Hungary, in 1902, and took his Ph.D. in 1909 at the University of Göttingen, Germany. He was awarded the degrees of Honorary Doctor of Engineering by the Technical University, Berlin, in 1929, and Honorary Doctor of Science by the University of Brussels in 1937. He was employed as a Mechanical Engineer at Ganz and Company, Budapest, from 1903 to 1906. In 1909 he became an Assistant Professor at the University of Göttingen and was Professor of Aeronautics and Director of the Aerodynamical Institute at the University of Aachen from 1913 to 1930. From 1922 to 1928 he was Advisor to the Junker Airplane works and in 1930 became a Professor of Aeronautics and Director of the Guggenheim Aeronautics Laboratory at the California Institute of Technology. In 1945 he was appointed Director, Scientific Advisory Group, Office of the Commanding General, Headquarters Army Air Forces. He returned to his post at California Institute of Technology in 1946.

Dr. von Kármán received the Institute's Sylvanus Albert Reed Award for 1941 and the American Society of Mechanical Engineers Medal for 1941. He was recently awarded membership in the Royal Society, England, an honor held at the present time by only 47 foreign scientists. The status of foreign membership compares with that of "Fellowship" awarded by the Royal Society to eminent British scientists.

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Institute Members Decorated

Three Institute members received decorations on June 18 from Gen. Carl A. Spaatz, Commanding General of the U.S. Army Air Forces, for wartime contributions to aeronautical research. They are Th. von Kármán, Honorary Fellow of the Institute and Director of the Guggenheim Aeronautics Laboratory at the California Institute of Technology; Hugh L. Dryden, Honorary Fellow of the Institute and Assistant Director of the National Bureau of Standards; and Frank L. Wattendorf, Associate Fellow of the Institute and Head Aeronautical Engineer, U.S. Army Air Forces at Wright Field.

Gifts to the Aeronautical Archives

Mrs. A. Leo Stevens presented four large silver cup trophies in memory of her late husband, A. Leo Stevens. These were among the honors conferred upon Mr. Stevens during his long and active career in the service of aeronautics. For several years before his death he gave the Archives books, letters, medals, and mementos from his personal collection and files, and Mrs. Stevens has added gifts with the same generosity. The four trophies have been placed in a special glass case in the Aeronautical Museum. The following inscriptions are on the trophies:

(1) Presented to A. Leo Stevens as an appreciation and with best wishes from the Dayton Chamber of Commerce, Dayton, Ohio, September 22, 1910.

(2) To the pilot making the longest flight in a spherical balloon during the year 1910 from any point in the New England states. Aero Club of New England trophy, presented by Cortland Field Bishop, President of the Aero Club of America.

(3) Presented to A. Leo Stevens by members of the Aero Club of America in appreciation of his work in furthering interest in aeronautics in America, December 1, 1908.

(4) To A. Leo Stevens. Universal Film Manufacturing Co. for his remarkable ascension from Madison Square Roof Garden on the occasion of the opening of the First National Motion Picture Exposition, May 16, 1916.

Mrs. H. W. Harms presented books and pamphlets on air power and military aeronautics and 32 maps in memory of her late husband, Col. Henry W. Harms, an Associate Fellow of the Institute. Colonel Benjamin F. Castle sent photographs of military airplanes and several pamphlets, including an

article by Augustus Post with his autograph and a signed note by Alan R. Hawley regarding their St. Louis–Quebec balloon flight. Aeronautical books, magazines, pictures, programs, and clippings were sent by Miss Dorothy Monro, adding to her previous gifts.

A signed copy, specially made for the Archives, of the symphony, "The Airborne," was presented through the courtesy of the composer, Marc Blitzstein. Mrs. Bella C. Landauer added to the large collection of aeronautical china by a gift of a rare bowl dating probably from the eighteenth century. It is the only bowl in the collection and supplements the many plates of the period she has previously given to the Institute.

The Air Documents Division of the Air Matériel Command at Wright Field sent a microfilm copy of the *ZWB Index* of the German Zentral für Wissenschaftliches Berichtswesen über Luftfahrtforschung, covering published reports and periodicals of the war years. The Air Documents Division sent also 20,000 cards of the *Air Documents Index*, which is being compiled at Wright Field, covering technical reports of German research agencies and companies on new developments in aeronautics.

John P. V. Heinmuller added an air-express label of Honduras, 1927, to his previous generous gifts. The Cornell Research Laboratory sent more than 1,000 aeronautical periodicals, through the courtesy of Elma T. Evans, adding to its previous gifts. The Emergency Public Works Commission of Massachusetts sent a report on terminal facilities at Logan International Airport, East Boston, through the courtesy of Hall Nichols. Dr. Alexander Klemin added books and pamphlets to his previous generous gifts. Photographs on the test and research facilities of Aeromatic Aircraft Propellers were received through the courtesy of John D. Waugh.

Col. Stedman Shumway Hanks gave eight moving-picture reels of airports and airplanes of the United States and Germany, adding to his previous generous gifts. The British Supply Office in Washington added ten *British Air Ministry Translations* to the large number previously given. The Durand Reprinting Committee, at the California Institute of Technology, added 15 reproductions of these translations to the large number previously given. Aeronautical insignia were received from American Airlines, Inc., and International Airlines, Inc. Dr. Eugene F. Du Bois gave more than 300 reports of aeromedical research centers published during the last five years. E. J. Young presented 16 aeronautical lapel pins.

Documents relating to applications for new air routes and extensions of existing routes before the Civil Aeronautics Board were received from Braniff Airways, Inc.; Eastern Air Lines, Inc.; Pan American Airways, Inc.; Transcontinental & Western Air, Inc.; and United Air Lines, Inc.

Additional gifts were received from the Aircraft Industries Association of America, Inc.; British Air Ministry; Aluminum Company of America; Burnham and Company; William S. Friedman; Dr. Alexander Klemin; Link Aviation Devices, Inc.; North American Aviation, Inc.; South Wind Division, Stewart-Warner Corporation; G. E. Stechert and Company; and the U.S. Government Printing Office, Bureau of Aeronautics of the Navy Department, National Bureau of Standards, Naval Air Transport Service Command, Office of Education, Smithsonian Institution, Department of State, and the House Document Room.

Sections and Branches

Boston Section

On May 14 the first meeting of the newly organized Boston Section was held at Massachusetts Institute of Technology. Dr. Sanford A. Moss, Consulting Engineer, Supercharger Engineering Division, General Electric Company, presided over the program. Elected to office were Prof. C. Fayette Taylor, Massachusetts Institute of Technology, Chairman; Prof. R. E. von Mises, Harvard University, Vice-Chairman; W. O. Meckley, Application Engineer, General Electric Company, Secretary; and C. A. Edman, Design Engineer, General Electric Company, Treasurer. Capt. S. Paul Johnston, Director of the Institute, addressed the group briefly on the functions of the Institute and the Institute's relation to the Boston Section. Professor Haertlien, President of the Engineering Societies of New England, described the activities of that organization and the benefits to be derived from affiliation with it.

Arthur H. Tully, Jr., former Massachusetts Commissioner of Aeronautics, spoke on the subject, "Massachusetts Airports." Mr. Tully described the functional organization responsible for the planning and construction of the Logan International Airport at East Boston and traced the history of this project. He discussed details of the construction of runways and the philosophy behind the runway layout. The airport will have a triangular runway layout and will have initially three 7,000-ft. runways. Two runways will be extended to 10,000 ft. and one will be extended to 8,000 ft. Mr. Tully described the condition of Bedford Airport and other Massachusetts airports, pointing out that there are inadequate facilities for private flying in Massachusetts because of reluctance of townships to authorize the building of new airports in their towns.

The Bell Aircraft Corporation film *Report on Jet Propulsion* was shown.

Los Angeles Section

At a meeting held on May 24, C. L. Johnson, Section Chairman, announced that the new Constitution and the personnel of the Advisory Management Committee had been approved in a letter ballot by the Section membership. He also announced that building plans were being checked by the Building Committee and on completion of this final check plans would be turned over to the Advisory Management Committee, which in turn would ask for bids on the building contract.

B. T. Salmon, Chief Engineer, Ryan Aeronautical Company, spoke on the subject "Development of the Ryan Fireball." Mr. Salmon discussed the merits of the combination reciprocating engine-jet propulsion power plant as applied to contemporary aircraft and in particular to the Ryan Fireball. Following the discussion period Willis Hawkins, Jr., Chief Preliminary Design Engineer, Lockheed Aircraft Corporation, presented a motion picture of the spin recovery tests on the Lockheed P-38.

Miami Section

On June 6 a meeting was held in the Miami Springs Country Club under the chairmanship of B. C. Stephens. E. E. Nelson, Sales Manager, Jet Aircraft Corporation, spoke on the subject "Jet or Jet-Assist for Aircraft and Boats." Mr. Nelson showed three films to illustrate his talk, *Jet-Assist on the Army Engineers Storm Boat, Jet-Assist for Take-Off on the Lockheed P-80 Shooting Star*, and *Jet-Assist for Take-Off on Douglas DC-3*. The jet engine shown in each film produced 1,000 lbs. of thrust for 12 sec. On the storm boat it completely replaced the outboard motor, which eliminated the possibility of starting failures and pushed the boat at a high speed for 1,500 ft. from standstill, sufficient to cross many rivers and streams. The jet engines on the aircraft were to create

a shorter take-off run and clear a 50-ft. obstacle. The best efficiency was obtained by igniting the jets after the aircraft obtained a speed of approximately 70 m.p.h. Various types of take-off were tried on the DC-3, using such combinations as one engine and one jet, one engine and two jets, two engines and one jet, or two engines and two jets. With two engines and two jets a take-off distance of 900 ft. was measured on initial rate of climb of 2,300 ft. per min. while the jet was still operative. All tests were conducted with gross loads.

During these performance tests much useful data were recorded. A rise of only 26° was noted along the belly of the aircraft in the wake of the jet exhaust. The jet exhaust could not be ignited by either 100-octane gas or kerosene passed directly over the jet engine and its exhaust. If the jets are properly mounted and located, little instability results from their thrust. The aircraft may easily be handled with brakes if the jet is accidentally ignited while taxiing. The aircraft may be decelerated and completely stopped by the use of brakes after the take-off has been initiated and jet engines ignited. The drag created by a jet engine mounted outside is equivalent to the flat-plate drag of a 10-in. circle. A discussion period on the theory of the propulsive jet motors followed.

Philadelphia Section

At a meeting of the Executive Committee held on June 19, the following Committee Chairmen were appointed: John S. Kean, Nominating Committee; John Rogers, Fellowship Committee; Adolph Herzog, Membership Committee; and Albert Wolf, Publicity Committee. H. R. Young was appointed to serve on the Advisory Committee. The program of speakers and papers for the season beginning in September was discussed.

On June 25 a meeting was held at the Engineers Club of Philadelphia, presided over by Carl de Ganahl, Section Vice-Chairman. The principal speaker was Louis P. Clark, Physicist, Head of the Vibration and Flutter Section, Naval Air Experiment Station, U.S. Naval Base, Philadelphia, who spoke on the subject "Flutter—Aero-Elastic Instability Investigations in Aircraft." Mr. Clark discussed the concept of flutter, the requirements for its existence, and typical measures that may be used to prevent or retard its occurrence. He then gave a brief survey of the most common flutter modes and a summary of procedures used in flutter analysis, including the derivation of equations and the most frequently used analytic and vector solutions of such equations. The talk also covered the effect of control-surface balance and other parameters on flutter speed.

On July 2 a dinner meeting was held at the Engineers Club of Philadelphia in honor of Air Commodore Frank Whittle of the Royal Air Force. Air Commodore Whittle repeated at this meeting the lecture first given at the special meeting of the New York Section. The meeting was presided over by Carl de Ganahl, Section Vice-Chairman, and the Toastmaster was Frank G. Tatnall, Chairman of the Advisory Committee.

Academy of Aeronautics

At a meeting held on May 21, Roy M. Bistline was elected Sergeant-at-Arms. Chairman Alphonse Parzel presided. On May 27 the film *Smoke Flow* was shown.

University of Alabama

David W. Crockett is the winner of the Student Branch Scholastic Award of the Institute at the University of Alabama Student Branch.

Carnegie Institute of Technology

The following officers were elected at a reorganization meeting of the Carnegie Institute of Technology Student Branch: Donald Cotton, Chairman; William W. Weitzenkorn, Secretary; and Richard Barker, Treasurer. Prof. Allen H. Blaisdell remains as Honorary Chairman and will be assisted by Earl W. Obringer, Instructor in Aeronautical Engineering.

The Catholic University of America

Charles R. Beek has been chosen to receive the Student Branch Scholastic Award at the Catholic University of America.

University of Detroit

The Student Branch Lecture Award will be presented to E. Frank Prosser for the development and presentation of his senior thesis on the subject "Criteria for Airport Layout and Design." Francis G. Olsen is the winner of the Student Branch Scholastic Award.

Georgia School of Technology

At a meeting held on June 6 the following officers were elected: Lamar A. Ramos, Chairman; Theodore A. Vogel, Vice-Chairman; Harlo A. Hunter, Secretary; and Charles R. Pendleton, Treasurer. An operational film of the U.S. Navy SB2C was shown. Retiring Chairman Charles H. Green presided.

Polytechnic Institute of Brooklyn

The Student Branch Lecture Award at Brooklyn Polytechnic Institute has been presented to Bernard Levine for his talk on "Biological Aspects of High-Altitude Flight."

University of Michigan

On June 4 a meeting was held, at which the following officers were elected: M. P. Murphy, Chairman; Karl Stevens, Vice-Chairman; Bill Milner, Secretary; Harry Apoian, Treasurer; and Dave Brennan, Engineering Council. Retiring Chairman Dave Brennan presided.

North Carolina State College

At a business meeting at the North Carolina Student Branch the following officers were elected: Maurice B. Dunn, Chairman; Andrew J. Patton, Vice-Chairman; William M. Bland, Jr., Secretary; and Glenn H. Adair, Treasurer.

University of Oklahoma

Alvin E. Petrik has been selected as the recipient of the Student Branch Scholastic Award. The Student Branch Lecture Award will be presented to Donald Malvern.

Tri-State College

At a meeting held on May 6, Mr. Glassemeyer spoke on the subject "Engineering on the B-24." On May 13, Robert May gave a lecture titled "Engineering on the B-29." A Transportation Committee was elected for the forthcoming trip to Meyers Aircraft Company, Tecumseh, Mich. Chairman Joseph Sveda presided.

On May 24 the members of the Student Branch and Prof. S. Acton, Faculty Adviser, toured the plant of the Meyers Aircraft Company. The 2-hour tour was conducted by N. Cosner, Assistant Chief Engineer of the company, who showed the group the engineering department and discussed engineering procedures. The group inspected the static-test equipment and progressive-step production line, in addition to the company's newest airplane developments.

University of Tulsa

At a meeting held on May 2 in the Phillips Engineering Building the following officers were elected: William Boyd, Chairman; James Kirkland, Vice-Chairman; and Constance Cook, Secretary-Treasurer.

News of Members

Burnham Adams has been appointed West Coast Sales Manager of the Electro-Mechanical Division of Lear, Incorporated.

Alfred Africano has been elected a Director and Chairman of the Committee on National Organization of the American Rocket Society.

Francis B. Alexander is taking his apprenticeship at the Westfield Flying Service, Salem, Ill.

Serge A. Alexeeff is now a Stress Engineer at Central Aircraft Corporation.

George T. Allen has joined Simmonds Aerocessories, Inc., as a Development Engineer.

Thomas A. Amneus is now a Structural Designer with the firm of S. B. Barnes.

Norman J. Asher has joined The Glenn L. Martin Company as an Aerodynamicist.

Frank W. Bajkowski has joined North American Aviation, Inc., as a Stress Analyst.

Donald L. Baker is now an Aeronautical Engineer at The Glenn L. Martin Company.

Albert C. Ballaseyus is now a Staff Engineer at Ford, Bacon & Davis, Inc.

Alb C. Ballauer has joined the Helicopter Research Division of McDonnell Aircraft Corporation as a Research Engineer.

Thomas Barish is now a Consulting Engineer for the Aeroproducts Division of General Motors Corporation and for Watson-Flagg Machine Company.

Louis E. Barnes is a Partner in the firm of Barnes & Hopkins.

George E. Bartlett has joined the experimental part of the Aerodynamics Section at Cornell Aeronautical Laboratory as Group Leader.

Melville W. Beardsley is now an Aerodynamicist at Northrop Aircraft, Inc.

Carl A. Beck has joined United Air Lines, Inc., as a Radio, Electric and Instrument Engineer.

Edward S. Becker, Jr., is now a Designer at the Ryan Aeronautical Company.

Harold G. Behl has joined the Special Powerplants Group of Boeing Aircraft Company as an Engineer.

Maurice Belzer is now an Engineering Designer at North American Aviation, Inc.

Vincent J. Berinati has joined Fairchild Personal Planes Division of Fairchild Engine and Airplane Corporation as Chief of Structures.

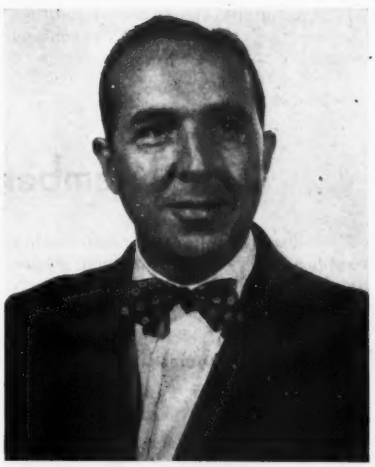
Henry Berman is now a Stress Analyst at Republic Aviation Corporation.

Gilbert C. Best has joined Consolidated Vultee Aircraft Corporation as a Stress Analyst.

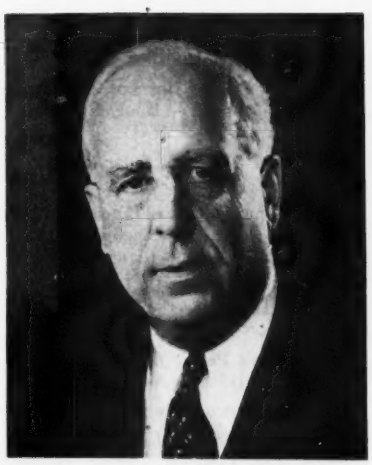
Jean Booth is now an Instructor in the Meteorology Department of the Aviation Technical School operated by the Brazilian Ministry of Air.

Robert M. Bram is now an Aeronautical Design Engineer in the Engineering Department of the Chance Vought Aircraft Division of United Aircraft Corporation.

Vincent J. Berinati.



John P. D. Garges.



P. W. Litchfield.

Chauncey M. Brewer is President of the firm of Brewer & Porter.

St. George A. Brown has joined The Glenn L. Martin Company as an Engineering Draftsman.

Louis Bruchiss has been elected a Director and Editor of the *Journal of the American Rocket Society.*

Robert C. Brumfield is to receive the first Richard L. Templin Award of the American Society for Testing Materials for his paper, "A Sulfur Print Method for the Study of Crack Growth in the Corrosion-Fatigue Metals."

George S. Cherniak is now an Engineer at Lessells and Associates.

Edward R. Child has joined Fredric Flader, Inc., as Principal Engineer.

Robert E. Coffman is now a Pilot Captain for Colonial Airlines, Inc.

Frank T. Coffyn has joined United Helicopters, Inc., as Director of Public Relations.

Frank M. Crosby is now an Instructor at Purdue University.

Lofton De S. Crow has joined Transcontinental & Western Air, Inc., as a Service Engineer.

Albert L. de Graffenried is now an Instructor in the Aeronautical Engineering Department of Rensselaer Polytechnic Institute.

Charles H. Dodge has joined the Jet Propulsion Laboratory of the California Institute of Technology as a Senior Research Engineer.

Daniel O. Dommasch is now a Project Engineer at Bell Aircraft Corporation.

Vernon G. Emrich has become a Development Engineer in the Aircraft and Marine Division of the Globe Corporation.

Raymond M. Foster is now an Aerodynamicist "A" at Consolidated Vultee Aircraft Corporation.

Clifford C. Furnas has been made Director of Cornell Aeronautical Laboratory.

Kenneth M. Galloway has joined McDonnell Aircraft Corporation as a Layout Draftsman.

John P. D. Garges is now Chief Engineer of the Fairchild Personal Planes Division of Fairchild Engine and Airplane Corporation.

Pollard Garrison has joined Transcontinental & Western Air, Inc., as Coordinator of Equipment Planning.

Valerian N. Gartseff is now a Structures Project Engineer at Republic Aviation Corporation.

Werner H. Geiger has joined Republic Aviation Corporation as a Draftsman.

Cedric Giles has been elected a Director and Chairman of the Membership and Nomination Committee of the American Rocket Society.

Frank D. Graham is now a Research Assistant at the Aeronautical Engineering Laboratory of Princeton University.

Morgan A. Gunst, Jr., has joined the Radiation Laboratory at the University of California as an Assistant Executive.

Lt. Comdr. Beckwith Havens has returned from active duty with the U.S. Naval Reserve to enter private business.

Henry L. Hayes is now a Stress Analyst at Beech Aircraft Corporation.

Westcott Heath, Jr., has joined Titeflex, Inc., as a Project Engineer.

Lt. Chih-Tsien Huang is now an Engineer with the Chinese Air Force.

Capt. John J. Ide, U.S.N.R., has been appointed Assistant Naval Attaché for Air at the American Embassy in London.

George S. Ireland has been elected President of The Walz Corporation.

Oliver H. Jacobson has joined the Marquardt Aircraft Company as Eastern Representative.

Rudolph A. Johnson is now a Student at Indiana Technical College.

Russell C. Johns has joined the Air Review Publishing Company as General Manager.

C. S. Jones has been elected a Director of Atlantic Central Airlines, Inc.

Temple N. Joyce has become President of Wing Engineering Corporation.

Meyer Klein has joined Taylorcraft Aviation Division of Detroit Air-Craft Products, Inc., as a Design Engineer.

Otto T. Kreusser has been appointed Engineering Administrator of the Allison Division of General Motors Corporation.

Charles I. Lathrem has joined the Engineering Staff of Aircooled Motors, Inc., as Propeller Engineer.

Paul A. Libby is now an Instructor in Aeronautical Engineering at the Polytechnic Institute of Brooklyn.

Gordon S. Light has joined the Ryan Aeronautical Company as a Designer.

Jack R. Lind is now an Ensign in the U.S. Navy.

Paul W. Litchfield, Chairman of the Board, The Goodyear Tire and Rubber Company, has been awarded an Honorary Degree of Doctor of Science by the University of Akron "in recognition of distinguished service to humanity."

David W. Lueck has joined the Department of Aeronautical Engineering at the University of Michigan as a Research Assistant.

John C. Luttrell is now President of Luttrell & Senior, Inc.

Edward T. Martin has joined American Airlines System as an Engineering Pilot.

Lt. Col. Kenneth G. Merriam has returned from active duty with the U.S. Army to rejoin Worcester Polytechnic Institute as Professor of Aeromechanics.

Jerome B. Meyer has joined Taylorcraft Aviation Division of Detroit Air-Craft Products, Inc., as a Structural Design Engineer.

Leonard Meyerhoff has received his Master's Degree in Aeronautical Engineering from New York University.

James R. Nolan is now an Engineering Designer at Consolidated Vultee Aircraft Corporation.

Virgil J. Norris has joined Aircraft Service Corporation as Personnel Director.

William O. O'Connor is now a Designer at North American Aviation, Inc.

James S. Ogsbury has been elected President of Fairchild Camera & Instrument Corporation.

Earl C. Peters has become a Partner in the aviation consulting firm of Drew and Peters.

Richard H. Prewitt, formerly Vice-President and Chief Engineer of Kellett Aircraft Corporation, has established an office for general consultation work on helicopter research, production and management problems.

Charles T. Roelke has been appointed Assistant Chief of Eastern Field Engineering for Pratt & Whitney Aircraft Engines, by United Aircraft Service Corporation.

Earl R. Southee, Manager of the Aviation Department of the Hilliard Corporation, has been appointed Manager of the Thirteenth Annual National Soaring Contest at Elmira, N.Y.

John R. Spreiter is now an Aeronautical Engineer at the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics.

William B. Terry, Jr., has joined Canadair, Limited (Canada) as a Stress Analyst.

Paul W. Thomas has been elected Chairman of the Board of the Helicopter Research Corporation.

Henry Thompson is now a Metallurgist at Bahrein Petroleum Company, Limited.

Peter Torraco has joined the Pilotless Plane Division of Fairchild Engine and Airplane Corporation as a Project Engineer.

Henry F. Waring, Jr., is now an Aerodynamicist at North American Aviation, Inc.

Louis J. Weber has joined North American Aviation, Inc., as a Stress Analyst.

Comdr. Carl J. Wenzinger, U.S.N.R., has been appointed Head Aeronautical Engineer and Civilian Chief of the Aeromechanics Division at the David Taylor Model Basin of the U.S. Navy.

Gordon H. Wheatley is now a Student in Engineering at the University of British Columbia (Canada).

Albert I. Wiebe, Gage Technologist at Quartermaster Inspector Service Headquarters, U.S. Army Service Forces, has received the War Department Emblem for Meritorious Civilian Service for his work in designing "more than one hundred inspectional aides and devices which have saved thousands of man hours."

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Fontaine, Athanas Paul, Director of Engineering, Bendix Aviation Corp.

Mason, Jack, A.B.; Project Engineer, Aero. Lab., Consolidated Vultee Aircraft Corp.

Paxton, Charles Norman, A.B. in M.E.; Comdr.—Chief Engineer, Pilotless Aircraft Unit, U.S. Navy.

Elected to MEMBER Grade

Anderson, Philip Norman, B.A. in Ae.E.; Designer "A," Douglas Aircraft Co., Inc.

Beck, Niels Christian, A.B.; Supt. of Instruction, Parks Air College.

Bottaro-Lopez, Alfredo Francisco Manuel, M.E.; Consulting Engineer—Aeroposta Argentina Airlines (Argentina).

Clauser, Milton Ure, Ph.D.; Chief of Mechanical Design Section, Douglas Aircraft Co., Inc.

Crook, Frank Peter, Jr., B.S.; Structures Analyst, Douglas Aircraft Co., Inc.

Dâtwyler, Gottfried, Ph.D.; Consulting Engineer (Switzerland).

Devlin, Leo John, Jr., M.E.; Chief Engineer, Douglas Aircraft Co., Inc.

Englebry, Channing Rowland, B.S. in Ae.E.; Aerodynamicist, North American Aviation, Inc.

Ewing, John Lawrence, M.S.; Capt., Director, Power Plant Div., Bureau of Aeronautics, U.S. Navy.

Greena, Haakon, Design Checker, Consolidated Vultee Aircraft Corp.

Hawthorne, William Rede, Sc.D.; Deputy Director of Scientific Research (Engines), Ministry of Aircraft Production (England).

Herrig, Lawrence Joseph, B.S. in M.E.; Aeronautical Engineer P-3, Langley Mem. Aero. Lab., N.A.C.A.

Holman, Donald Morison, Wing Commander, Canadian Joint Staff, Royal Canadian Air Force.

Hyde, Wason Morrell, Designer, The Glenn L. Martin Co.

Knipp, George Henry, B.S.; Stress Analyst, Douglas Aircraft Co., Inc.

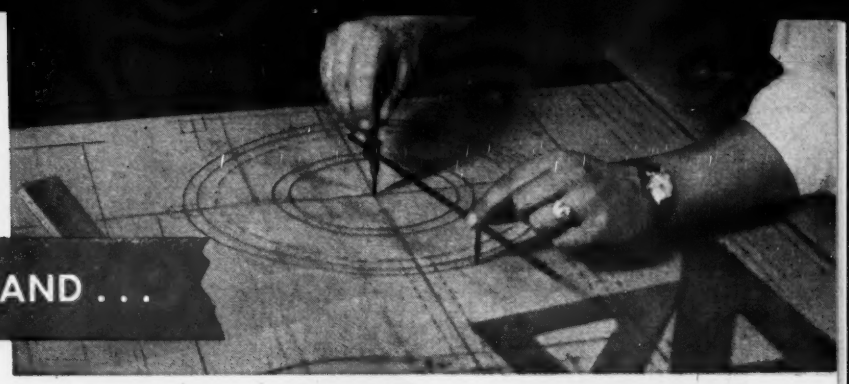
McCollum, Fenwick Harris, B.S.; Structural Engineer, Douglas Aircraft Co., Inc.

Neuls, George Scott, B.S.; Structures Engineer, Douglas Aircraft Co., Inc.

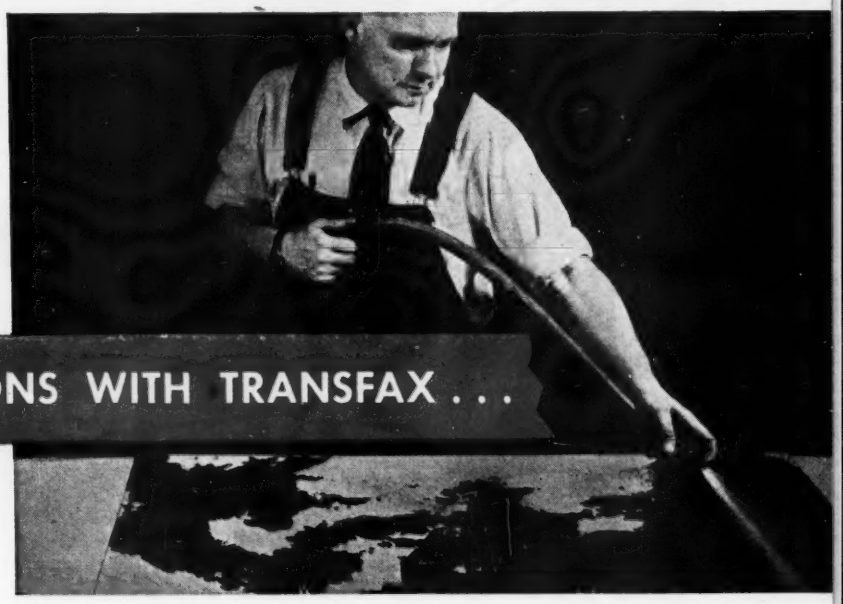
Porter, Firmin Deloss, Designer, Douglas Aircraft Co., Inc.

Putney, Gordon Wesley, B.S.; Stress Analyst, Douglas Aircraft Co., Inc.

Rhodes, Walter Cortlyn, Jr., B.S. in Ae.E.; Production Manager, Air Associates Inc.



DO THE ORIGINAL BY HAND . . .



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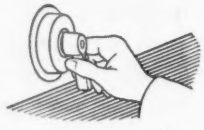

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WHEREVER WHEELS TURN OR PROPELLERS SPIN

Skifter, Hector Randolph, Sc.D.; President, Airborne Instruments Lab., Inc.

Stephenson, William Bruce, M.S.; Sgt.—Flight Test Analyst, Prop. Lab., U.S. Army Air Forces (Wright Field).

Strickler, John Franklin, Jr., B.S. in Ae.E.; Asst. Chief Engineer, Bell Aircraft Corp.

Stunkel, Reagan Calvin, A.A.; General Service Mgr., Lockheed Aircraft Corp.

Topham, Roland, M. and Ae.E.; Chief Inspector (Aircraft), Jackson Heywood Co. Ltd. (England).

Van Dyke, William Deaderick, B.S.; Research Engineer, El Segundo Div., Douglas Aircraft Co., Inc.

Wheeler, Frederick Charles, B.Ae.Sc.; Design Engineer, North American Aviation, Inc.

Wood, Frank Travers, Jr., A.B.; Process Engineer, Douglas Aircraft Co., Inc.

Wood, Marion Loren, B.S.; Patent Engineer, International Business Machines Corp.

Transferred to MEMBER Grade

Arnold, Allison Mansfield, B.S.M.E.

Butt, Charles Stahle, Jr., B.S.; Capt.—Chief, Airplane Sub Unit, Air Technical Service Command, U.S. Army Air Forces.

Gahm, Herman, Structural Engineer—Stress Department, Republic Aviation Corp.

Kayten, Gerald G., B.Ae.E.; Aeronautical Engineer, Bur. of Aeronautics, U.S. Navy Dept.

Kirk, Randall Willard, B.Ae.E.; Assistant Manager, DC-4 Conversion Project, Pan American World Airways, Inc.

Mayer, Frank Stephan, Jr., B.S. in Ae.E.; Lead Stress Engineer, Northrop Aircraft, Inc.

McCulloch, Alexander James, B.S. in Ae.E., A.F.R.Ae.S.; Structures Development Section—Engineering Dept., Chance Vought Aircraft Div., United Aircraft Corp.

Rosan, Howard Jouard, B.Ae.E.; Vice-President, Samuel D. Rosan Agency, Inc.

Smith, Robert Beaton, M.Sc. in Ae.E.; Supervisor, Aerodynamic Design Group, Douglas Aircraft Co., Inc.

Elected to Industrial Member Grade

Kaufman, Sidney, B.A.; Chief of Administration, A.A.F. Institute of Technology (Wright Field).

Macdonald, James Hector, M.Sc.; Chief Engineer, Technical Dept., Standard-Vacuum Oil Company (India).

Elected to Technical Member Grade

Bennett, Leon, B.Ae.E.; Jr. Engineer, Research Div., New York University.

Burnham, Charles Edward, B.S. in Ae.E.; Capt.—Chief, Special Project Unit, Engineering Div., U.S. Army Air Forces.

Oldfield, Bernard Edward, Eng. Tech. Adviser, Muroc Flight Test Base, U.S. War Dept.

Seemann, Howard Herman, B.Ae.E.; Test Research Engineer, Republic Aviation Corp.

Siry, Joseph William, B.Sc.; Lt.—Tech. Aide-Airborne Radio Div. and Jr. Tech. Aide for Aero. Research, U.S. Naval Research Lab., U.S.N.R.

Street, Lloyd Joseph, B.Ae.E.; Jr. Flight Test Engineer, The Glenn L. Martin Co.

Warsett, Paul, B.Ae.E.; Sr. Aerodynamicist, Propeller Div., Curtiss-Wright Corp.

Transferred from Student to Technical Member

Andrew, Henry Frick, B.Ae.E.; Ensign, U.S.N.R.

Bartholomew, Michael D.

Bindrim, William Frederick, Jr., B.-Ae.E.; Asst. Weight Engineer, G & A Aircraft, Inc.

Buford, William Ellerbe, B.Ae.E.; Jr. Aerodynamicist, The Glenn L. Martin Co.

Cipriani, Joseph Louis, B.Ae.E.; Ensign, U.S.N.R.

Clay, Franklin Edward, B.Ae.E.; Ensign, U.S. Navy.

Dobony, Charles, B.S. in Ae.E.; Ensign, U.S. Navy.

Doty, Frederick Cessna, B.Ae.E.; Ensign, U.S.N.R.

Eisele, William Henry, B.Ae.E.; Ensign, U.S. Navy.

Hawkes, Thaddeus Arthur, B.S.; Ensign, U.S.N.R.

Herr, Richard Donald, B.Ae.E.; U.S. Navy.

Huang, Paul Chang-chih, B.Ae.E.; Student.

Jacques, Herbert England, B.S.; Officer Engineer, Analytical Test and Development Section, Ship Installations Div., Naval Aircraft Factory, Naval Air Material Center, U.S. Naval Base (Philadelphia, Pa.).

Kasari, Elmer Bernhardt, B.S.; Ensign, U.S. Navy.

Knust, Thomas John, Ae.E.

McKercher, Donald Cameron, B.S.; Engineer, The Glenn L. Martin Co.

Neighbors, William Allen, B.Ae.E.; Reservations Agent, Pennsylvania-Central Airlines Corp.

Perry, Lindsey Jackson, Jr., B.S. in Ae.E.; Ensign, U.S.N.R.

Scudder, Lavern William, B.S.; Ensign, U.S. Navy.

Stevens, George Langridge, B.S. in Ae.E.; Ensign, U.S. Navy.

Treon, Stuart Leo, B.S. in Ae.E.; Ensign, U.S.N.R.

Van Branteghem, Ferdinand Noel, B.Ae.E.; Asst. Engineering Officer, U.S. Navy.

Yager, Walter Claiborne, B.S. in Ae.E.; Ensign, U.S. Navy.

I.A.S. National Meeting Schedule

Air Transport Meeting—October 24, 1946, Washington, D.C., Hotel Statler.

Tenth Wright Brothers Lecture—December 17, 1946, New York, N.Y., Location to be announced.

Fifteenth Annual Meeting—January 28–29–30, 1947, New York, N.Y., Location to be announced.

The Meetings Committee of the Institute invites participation in the technical sessions of the Fifteenth Annual Meeting of the Institute.

Members or organizations wishing to submit papers for this meeting should send complete papers, or outlines or summaries, to the Meetings Committee at least three months prior to the meeting. Outlines or summaries should not exceed 1,000 words.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review.*

All correspondence should be addressed to The Meetings Committee, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

Editorial

"First Citizen" for Air

Crisscrossing the world today are the tracks of a mysterious character—a legendary figure now of almost Bunyan-esque proportions. No matter where one goes, from the Aleutians to the Solomons, from Kunming to Berlin, there are traces of his passage—"Kilroy slept here" — "Kilroy was here" — "Kilroy" — "Kilroy"— "Kilroy." At every spot where anything of any consequence took place, "Kilroy" was among those present. He never missed.

Likewise, in the world of aviation, from the earliest years, across oceans, into the remote places of the globe, crisscrossing continents—going everywhere that wings could carry him—giving ever of his boundless energy and enthusiasm for the advancement of aviation—*Gardner* was there. *He* never missed.

To most of us still on the near side of fifty, there never was a time when Lester Gardner did not loom large on the aeronautical horizon. For many of us he has been Father Confessor and intimate advisor. He has always been ready to give a hand and to give recognition to those who were struggling to accomplish something in aviation.

Although he did not become definitely connected with aviation until 1915, his prior interest in, and his subsequent close association with, the famous figures of the early years would justify his inclusion among the air pioneers of America. His eventual leadership in research in aeronautical history has further fortified his position. No man has done more to secure and to preserve for posterity the important records and relics of the beginnings of flight.

But sound as such a basis might be, the living fame of Lester Gardner does not rest alone on his work as an aeronautical archivist. Very early he saw the vision of an America on Wings. With Tennyson, he "dipt into the future," saw "the heavens fill with commerce" and the clash of "Airy navies." His active mind quickly grasped the implications of the conquest of the air. He foresaw the importance of a strong aeronautical industry for the United States. His greatest ambition was to see his country gain and maintain leadership in the air. For thirty years, without stint, he has applied his peculiar talents toward that end.

Major Gardner made no solo flights across oceans. He designed no revolutionary aircraft. He fought no aerial battles. He wrote no aerial "best-seller." But he has always believed that the future of America in the air depended on the widespread dissemination of aeronautical knowledge and on the free interchange of ideas among engineers and scientists everywhere. His long years as an aeronautical publisher, his service on innumerable aviation committees and commissions, his fathering of the Institute of the Aeronautical Sciences stand as ample evidence of his unflagging devotion to that ideal.

This is not the place for a detailed recording of Lester Gardner's achievements. His career is too well known to need repeating here. It is written large across the skyways of the world so that "he who flies may read." For it, he has been justly honored by many countries.

On August 7, 1946, Major Gardner celebrated his seventieth birthday and began a well-earned rest from the heavy load that he has carried so well for so long. Although he has withdrawn from the active management of the Institute, he is giving to his successors the benefit of his advice and council.

With all who have been his friends and associates for many years, we rise and give to him a heartfelt "well done"—for the long years given so unselfishly to the advancement of the industry in which we all have a smaller part.

Lester D. Gardner

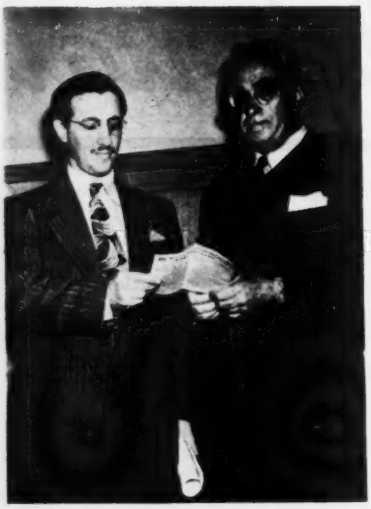
Personal Plane Problems

An Analysis of the Papers and a Summary of the Discussions at the I.A.S. Annual Light Aircraft Meeting, Detroit, June 13–14

by

RALPH UPSON

Consulting Engineer



Responsible for the success of the meeting —Peter Altman, Program Chairman (*left*) and Arthur Locke, Detroit Section Chairman (*right*).

THE Detroit Light Aircraft Meeting, now something of a tradition, lived up to its reputation for the quality of papers presented and the caliber of personnel in attendance. Over 200 I.A.S. members and guests attended the Technical Sessions held in the auditorium of the Rackham Educational Memorial.

The opening session on the afternoon of June 13, under the chairmanship of Raymond Hermes, Chief Engineer, Aeronca Aircraft Corporation, was devoted to two papers indirectly concerned with center-of-gravity movement.

Seating Arrangement

F. K. Teichmann, Head of the Department of Aeronautical Engineering, New York University, led off the session with his paper on "Optimum Seating Arrangement for Light Planes."

This paper made no pretense at being exhaustive in its treatment. It consisted mainly of dimensional requirements governing different seating arrangements based on Army measurements of some 3,000 air cadets. From these measurements the author took as his own standard the average dimensions of a man 6 ft. tall. This height presumably represents the maximum that a light plane is likely to serve.

It is interesting to note that a strict interpretation of the Army data leads to a required width at the elbows of 26 in. per person or 52 in. for two persons side-by-side. This is fully 10 in. wider than is found in most light planes and 5 or 6 in. wider than would probably be regarded as roomy for average civilian use.

Various possibilities for reducing the above spacing requirements include:

(a) Bending the knees, without or with finite seat height (the latter of course is the usual method).

(b) Space for extending feet under next seat forward, when available.

(c) Pickaback, or toboggan, style of leg arrangement—perhaps worth considering for an extra passenger.

(d) Staggered seating, a few inches being of considerable help.

(e) Diagonal and lateral seating, somewhat deficient in window vision.

(f) Back-to-back seating—of little, if any, benefit.

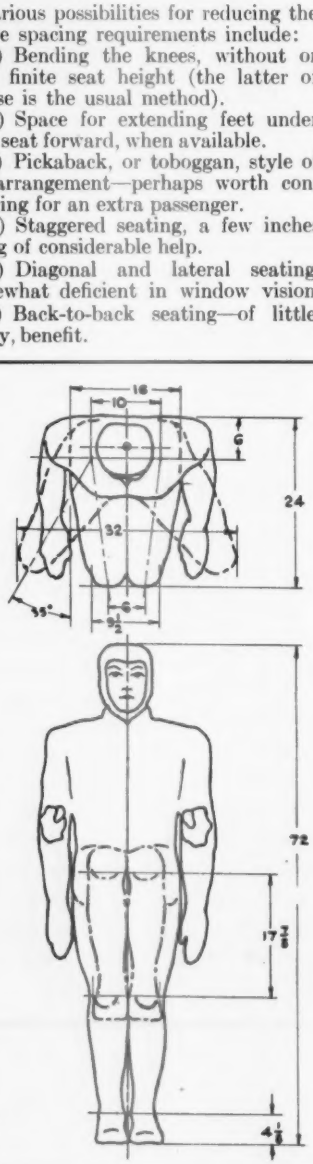
(g) Reclining backs; not recommended for pilot.

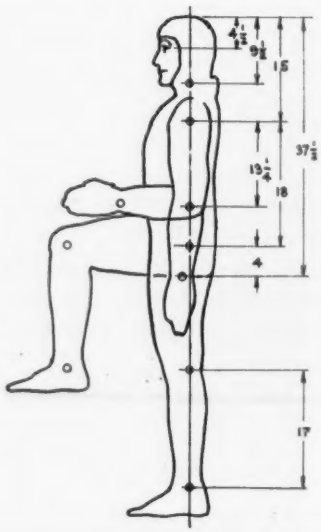
(h) Prone, on stomach (not greeted with any chorus of approval).

Although some kind of staggered side-by-side arrangement appeared generally favored by the author, he arrived at no specific conclusion beyond the closing opinion that the generally acceptable personal airplane must have at least the comfort of a conventional automobile.

Discussion

Richard H. Depew, Jr. (Ludington-Griswold) strongly seconded Professor Teichmann's closure by saying: "The usual design procedure seems to consist of establishing first the desired aerodynamic characteristics, and then fitting in the passengers as best we can. In-





Professor F. K. Teichmann's "Standard Man."

stead, we should make the passengers the first consideration and then do the best we can on the aerodynamics." John H. Geisse (C.A.A.) and J. M. Gwinn, Jr. (Consolidated) were in agreement.

Roger W. Griswold II (Ludington-Griswold) brought out that minimum frontal area does not necessarily mean minimum drag. Peter Altman (Consultant) countered that, for similar shapes and equivalent streamlining, drag could still be reduced by reducing frontal area which, he hastened to add, he was not necessarily recommending. (The judges would probably turn in "no decision" on that bout as there is really not much that can be done about the cabin height of the usual tractor plane. With the present horizontal engines, the cabin width appears to be a minor factor in the drag.) Eli E. Hayes (P.C.A.) called attention to the greater freedom of movement required by the pilot.

J. P. D. Garges (Fairchild) entered the lists with statistics prepared by Prof. E. A. Hooten, of Harvard, showing that 19-in. width per person is sufficient for 90 per cent of all people; also pointing out that Teichmann's 52 in. for two persons is the standard automobile width which readily seats three. Without recommending the practice, Herbert F. Kuech (Luscombe) cited a recent airplane design of 42-in. cabin width claiming room for three side-by-side. Teichmann here threw in the sponge by offering to compromise on anything from 40 to 52 in. that would suit the general style and quality of design.

Frank B. Lane (Engineering and Research Corporation) maintained the general feasibility of transverse seating for a rear passenger. Gwinn emphasized the importance of structural safety in seats and belts, likely to be critical with adjustable seats. Depew: "Speaking of safety, how about more safety in front of the pilot's head? Do away with instrument panels that assure a face full of instruments in a moderate crack-up." George H. Tweney (University of Detroit), Ralph Harmon (Beech), and Altman joined in a mutual plea for simplified access.

The Chairman pointed out the relation between seating, controls, and instrument position. Someone questioned the validity of Teichmann's 6-ft. standard man. "What about the 6 ft. 3 in. man?" queried Fred E. Weick (ERCO), which brought down the house as a masterpiece of understatement.

"But what about the six-foot three man?" asks Fred E. Weick (ERCO).

C.G. Movement

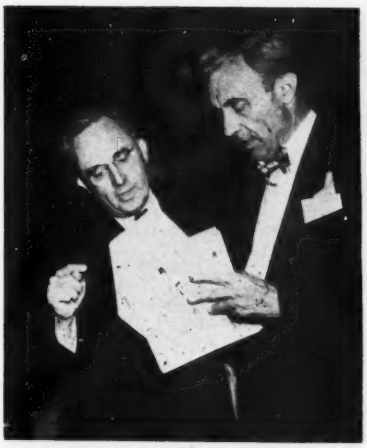
J. M. Gwinn, Jr., Chief Engineer for Personal Aircraft, Consolidated Vultee Aircraft Corporation, highlighted the following points on "The Effect of Center of Gravity Movement on Safety of Personal Aircraft."

The most obvious effects of c.g. movement are on longitudinal stability and trim. Such effects are particularly critical where restricted elevator control is used in producing a nonstalling or nonspinning airplane.

Admitting the practical difficulty of making adjustments to compensate for wide c.g. variation, the author maintained that it is not strictly necessary to make an airplane stallproof in order to make it spinproof. Moreover, a stalled condition has advantages, particularly for a steep-approach glide. With stick all the way back, the pilot has no means of checking his rate of descent whether the airplane is stalled or not. (The author does not mention that further flap deflection could still be used for the purpose and, in fact, gives a better means of checking the final vertical descent than use of the elevator.)

An airplane capable of striking the ground without injury at the end of a stalled glide was recommended, providing the stall be gradual and the airplane held in a substantially level attitude. (The latter seems a difficult requirement considering the steep flight path and the fact that angle of attack is the difference between the wing angle and the flight path angle. Possibly the author had in mind some kind of variable incidence wing.)

In the normal two-place, or three-place, tractor plane the author feels that the c.g. can be held nearly constant by making the c.g. of the airplane empty coincide with its c.g. fully loaded; but the engine must not be too heavy or located too far forward. With four or five places, he recommends two persons on the front seat and the others behind. (An approximately constant c.g. in this case appears possible only with an unusually light engine, implying relatively low performance. Normally, the rear passengers and baggage will be appreciably behind the c.g. The reverse is the case with a pusher, usually resulting in large c.g. travel.) The paper also stresses the importance of considering variable pilot weight.



Author Ralph Upson checks a few points with Consolidated's J. M. Gwinn, Jr.

To summarize, c.g. movement must be kept to a minimum to:

(1) Facilitate elimination of the hazards of the stall, as the c.g. moves back.

(2) With restricted elevator, prevent the minimum trim speed and the nose-down angle from increasing undesirably as the c.g. moves forward.

(3) Make more uniform the maneuvering characteristics of the two-control airplane in flight, both longitudinally and laterally.

(4) Improve the taxiing and cross-wind landing characteristics of tricycle landing gear.

The adverse effects of c.g. movement with restricted elevator control may be minimized by:

(1) Permitting flight with c.g. most aft at maximum lift coefficient.

(2) Having the gross weight increase as the c.g. goes aft.

(3) Providing a wing having a flat or round-top lift curve.

(4) Having the c.g. most-aft position below the c.g. most-forward position.

(5) Having high static longitudinal stability.

(6) Having a moment curve concave downward, such as with low c.g.

Discussion

It is said that tigers must *learn* to like human flesh. In this case they apparently learned plenty from the previous victim and were ready for a new one. Robert Sanders (Engineering and Research Corporation) advised that much more serious than the nose-down position is the uncontrolled loss of altitude resulting from the steep glide path in a stall. Gwinn replied that he is not recommending landing from a stalled glide as regular practice but only as an emergency possibility.

C. N. Sanford (Iowa State College) stated: "The advantages of a steep glide in a stalled condition are obvious; but suppose the pilot finds it is too steep and he is undershooting, what can he do?" Gwinn: "Give it some throttle.

Effects of a flap on lift is illustrated by J. M. Gwinn, Jr.

It's the best means of glide control anyhow."

J. H. Geisse (C.A.A.) and Lawrence M. Patrick (Wayne Engineering Research Institute) asked in different words but the same tune about lateral control, usually the most serious problem in a stall. Here Gwinn illustrated on the blackboard the fact that a simple flap, equivalent to an aileron, is capable of getting more lift out of a wing surface already stalled. He admitted large adverse yaw under such conditions but proposed counteracting it by high directional damping. (He failed to mention specifically the need for adequate damping in roll, probably the most important single requirement for lateral control.)

Bernard Maggin (N.A.C.A.) maintained that recent test results, not yet published, show that damping in yaw is of small importance. (By this he may refer to the magnitude of damping that appears to be within practical reach in normal design. Certainly true damping of yawing velocity, dependent on more than mere fin area, if attainable to a sufficient degree, would be a substantial aid in straight flight control.)

Peter Altman (Consultant) asked, "How do you get your flat-top lift curve without sacrificing maximum lift?" Gwinn: "You just sacrifice it, that's all. The extreme top of a sharp lift curve is no good to you anyhow. Another requirement for a modern airfoil is that it be designed for best results with flaps." (He might have mentioned here that the flat-top characteristics are particularly hard to attain with flaps.)

John Geisse: "How about spoiler-type ailerons?" Gwinn: "They look generally promising, but the scoop type has structural disadvantages and is bad for production."

Fred E. Weick (ERCO): "Aileron stall is eliminated by restricting stalling to the center portion of the wing." F. T. Kurt (Grumman) questioned whether there is an upper limit of wing loading beyond which stall control devices produce excessive and impractical sinking speeds. Gwinn thought there might be such a limit somewhere but ventured no figure, adding that this problem, as well as incidental dissymmetry of the wings, is alleviated by a flat-top lift curve.

V. J. Berinati (Fairchild) stressed the importance of stability in take-off, whereupon the discussion wandered still further from the subject into a free-for-all on pushers and thence to extension shafts. The Chairman saved the situation by observing the lateness of the hour, and the meeting adjourned.

The evening session of June 13 provided three papers of exceptional interest. Fred E. Weick, Vice-President in Charge of Engineering, Engineering and Research Corporation, presided.

Maintenance

In "Maintenance of Personal Aircraft," George H. Weitz, Chief of the Air Frame Section, Non-Scheduled Aircraft Maintenance Division, Civil Aeronautics Administration, developed many valuable points. For convenience these are reported in condensed form by item heads.

Military Surplus Airplanes. Relative to the original cost these are cheap in price but carry substantial hidden costs for operation, maintenance, overhaul and repair that should be appreciated in advance of purchase.

Shop Maintenance. In the author's opinion this is one of the greatest obstacles in the way of mass flying. Overloaded shops, too few skilled mechanics, and unsuitability of the aircraft themselves to production maintenance are equally blamed.

Owner Maintenance. The plane owner is now given the authority to perform certain items of preventative maintenance, including adjustment of controls, landing gear, electrical system, and valve tappets; cleaning of ignition points, oil and fuel strainers; servicing or replacing plugs, fuel and oil hoses. He may also smooth the propeller blades and replace various parts, including tires and windshield. The owner will doubtless save money by performing these jobs himself providing he has the requisite knowledge and technique. But a simple error of technique, such as putting too much torque on a stud, may be a ticket to plenty of trouble.

Miscellaneous Advice to Owner. Attend promptly to necessary service changes. See that a plane parked outside is properly secured. Keep handy a small kit of tools and some useful supplies.

Recommended Design Features. Sectionalized fuselages, wings, and other component parts, preferably small enough to permit shipment as air cargo. Engine accessibility and quick-change engine mounts. Suitable jack points. Larger and better-distributed inspection openings, with covers designed for frequent removal. Common replacement parts widely distributed, including necessary repair kits and full instructions; replacements designed if possible for handling with the ordinary mechanic's tool kit.

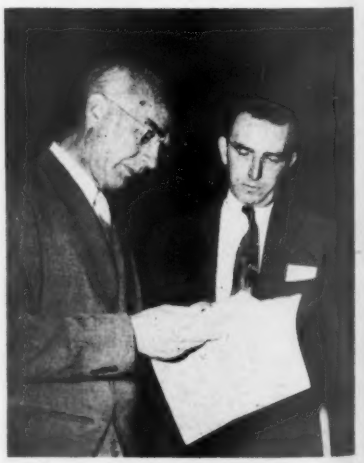
Advice to Repair Stations. Offer fixed prices for almost every type of repair or service item, exclusive of hidden damage. Maintain adequate supervision and inspection. The latter must always be by some competent person other than the one who performed the work. Be frank in advising customers how to reduce maintenance costs.

Improvement in Regulations. There are now over 500 competent mechanics who have been authorized to assume responsibility for annual inspections, and the immediate goal is 1,000 operating at as many centers as possible. Paper work has been reduced, only one short form being required for the average annual inspection. Every C.A.A. district office has been equipped with a complete technical library. Joint action with the manufacturer is taken on corrective measures for any difficulty that appears chronic. Nonstandard alterations or repairs may be approved by a C.A.A. engineering representative in the field.

The paper closed with a prediction of the convenience and economic benefits from increased production and the more widespread availability of standard parts. By 1950 we should have 1,000 approved repair stations, plus some 3,000 airport shops, capable of handling well over 100,000 airplanes,. a large number of them simple-control, nonspinning, with features conducive to rapid maintenance.

Discussion

Peter Altman (Consultant) supported the fixed-price policy. F. T. Kurt (Grumman) held that the present mechanics' licensing rules are too specialized, upon which Depew remarked: "Too many specialists required." Weick (ERCO) reported progress on built-in maintenance. Leslie Trigg (Sensenich) said: "Each kind of part poses a problem as to whether more emphasis should be put on serviceability or ease of replacement since certain components,



John Geisse (C.A.A.) looks over a meeting paper with I.A.S. Secretary Robert R. Dexter.

because of the fact that they are by nature complex, should probably be returned to their manufacturers, rather than serviced in the field by inexperienced personnel."

On a question about average or prevailing maintenance costs, George H. Tweney (University of Detroit) gave evidence from club operation indicating that the total cost per year (everything except depreciation) runs about one-half the initial airplane cost based on a plane operated about 200 hours per year. (See also Berboth's slightly lower figures quoted from the closing symposium.)

Noise

Theodore Theodorsen, Head Physicist, Chief of Division of Physical Research, and Arthur A. Regier, Electrical Engineer, Division of Physical Research, Langley Memorial Aeronautical Laboratory, National Advisory Committee for Aeronautics, treated "Noise Reduction in Light Airplanes." This paper, presented by Dr. Theodorsen, gave an authoritative treatment of the subject based on the premise that although engine noise can be readily subdued by well-known methods, it is to little purpose unless the propeller noise is also substantially reduced. Although prospects of the latter have in the past been considered almost hopeless, the paper showed how, for relatively small engines at least, propeller noise can be not merely reduced but perhaps almost eliminated by a combination of multiple blades and low tip speed. Based on 100 per cent noise as measured in decibels for two blades at a Mach Number of 0.85, four blades at a Mach Number of 0.5 would reduce the noise about 25 per cent, and eight blades at a Mach Number of 0.25 would reduce the noise about 90 per cent, based on an airplane traveling 75 m.p.h. (The more likely airplane of the future traveling nearly twice this speed could presumably not be silenced so much.)

"Four dollars a horsepower?—maybe—" says Carl Doman, of Aircooled Motors, Inc.

Discussion

Leslie Trigg (Sensenich) questioned vibration troubles with multiple blades of thin section. Theodorsen thought this would probably not be bad at small power but was not so certain for anything much over 100 hp. Fred E. Weick: "50 per cent reduction of decibels would probably be thought quite satisfactory." Theodorsen: "25 per cent would be well worth-while and further reduction may be possible with counterrotating propellers." C. N. Sanford suggested the sound-reducing effect of a shroud ring, but Theodorsen thought this would be ineffective, since sound depends on torque and thrust. Eli E. Hayes: "Would not such a ring still shield some of the sound waves?" Theodorsen: "No, because they are so long in proportion to the propeller diameter."

Walter Jamouneau (Piper): "Experience seems to show quite definitely that a high wing transmits more noise to the ground than a low wing, presumably due to the soundboard effect. Experience with mufflers shows them to be worth-while on light planes even with no particular attempt to silence the propeller." Theodorsen still thought, however, that the net effect in both cases would be minor.

Grover Loening (N.A.C.A.) added to the testimony, from experience, that the position of the propeller on the airplane seems to make a difference, pointing out particularly the relatively large noise usually made by a pusher propeller (the pusher propeller being unusually close to the wing and just back of the exhaust). Roger W. Griswold II mentioned the muffling effect of exhaust cooling. (The December, 1945, issue of *National Aeronautics* contains an interesting article on noise reduction.)

The importance of this paper was further emphasized by Grover C. Loening's address at the dinner, in which he named noise as aviation's Number One problem at the present time.

Control

Because so many designers and engineers are not pilots, Wolfgang Langewiesche's paper "The Pilot and the Controls" was particularly pertinent. The author is Research Pilot, Kollsman Instrument Division, Square D Company, and an authority on his subject. His main plea was for improved consistency of the controls, with substantial movement and force variation, so that the pilot not only knows consistently and rationally how to produce a desired airplane maneuver but also knows from the control position and force what he is doing. (See page 25 for complete text.)

Walter Jamouneau (Piper) wants to give customers more for their money.

Discussion

Several of those present agreed that spoilers constitute a desirable and effective glide-path control. E. R. Burn (Goodyear) testified to their pleasant and consistent operation. Richard H. Depew, Jr. (Ludington-Griswold) pointed out their superiority to flaps, for glide-path control. John H. Geisse (C.A.A.) supported the author's recommendation for combining the throttle and spoiler control, but favored a separate pedal-operated brake. He revealed that the C.A.A. now permits slipping in spot landing tests and requires no forced landing practice. Langewiesche expressed gratification for this step because more fatal accidents have occurred in *practicing* forced landings than in *actual* forced landings.

E. R. Burn (Goodyear) questioned the desirability of dropping the rudder control entirely since it is so useful on a long trip for freeing the hands for navigation, etc. Langewiesche confessed that he had intended to chisel a little on his expressed principles by having a small rudder for sideslip purposes which also could be used for steering on occasion.

This stimulating paper promoted more discussion than was possible to accommodate at the meeting proper and there were rumors of an extemporaneous session at the Statler later lasting far into the night. There are evidently more possibilities than were brought out at the meeting on the general subject of control classification and coordination. For example, spoiler control might be classed as a brake rather than as a negative throttle, and there are occasions when maintenance of extra drag may be found desirable in conjunction with an open throttle. Certainly there can be no reasonable argument against the general consist-

ency of controls. The basis for such consistency, however, is still subject to considerable difference of opinion, which, by sufficient airing in future meetings of this kind, may soon crystallize into something definite that will merit full support from pilots and engineers alike.

The afternoon session of June 14 dealt with landing gear and engine problems. A. P. Fontaine, Director of Aircraft Development, Experimental Engineering Division, Bendix Aviation Corporation, was Chairman.

Landing Gear

William B. Westcott, Landing Gear Project Engineer, Electrol, Inc., spoke about "Simplified Landing Gear Design." The author's premise was that, although a simple sprung-type landing gear is satisfactory for an airplane up to 1,500 lbs. gross weight, the heavier planes of the future will require a more efficient unit. An air-oil strut with a fairly large displacement is a logical answer except for its hitherto high cost. Substantial cost reduction appears possible through simplified design and standardization of parts. Weight and cost must be considered in combination.

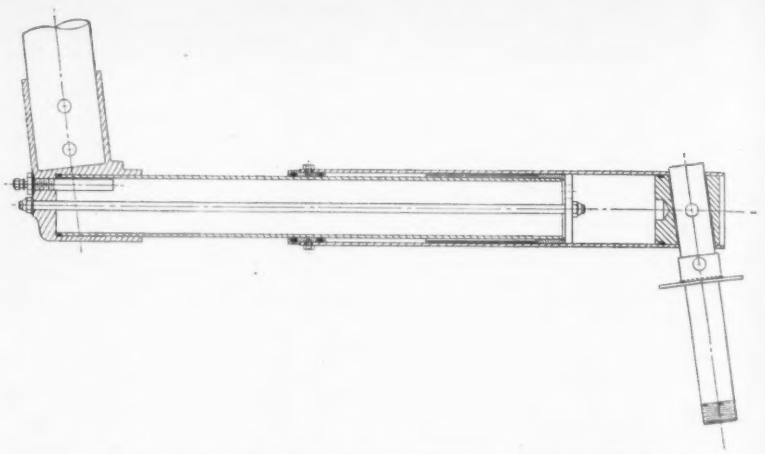
Data presented in curves showed that the optimum cylinder diameter is about $2^1/_2$ in. for a static load of 10,000 lbs. The author judged this to be the minimum practical diameter for all smaller loads. He recommended a 6-in. stroke as adequate to meet C.A.A. requirements. Aluminum alloy is held to be cheaper than steel because of its easier machining.

Unlike a large part of the airplane structure, low cost in the landing gear does not necessarily follow from a reduction in the number of parts. Rather it is in the breaking down of the assembly into parts that can be made by automatic machinery and in the reduction in the number of operations required.

Discussion

Opening the discussion J. M. Gwinn, Jr. (Consolidated) remarked that, in the general case, labor on parts must be balanced against labor for assembly. Westcott replied that much depends on the type of joint. Weick (ERCO) questioned the weight of the simplified type. Westcott stated: "The particular example on which this study is based weighed less than the conventional type. Atmospheric air cushioning has advantages but gives only about $^3/_4$-in. taxi stroke, even when the air is inserted in the extended position." R. W. Brown (Firestone) made an eloquent appeal for a long taxi stroke, heat-treated stampings, and against unnecessary weight. Westcott thought that relatively large production would be required to justify heat-treated stampings.

H. F. Kueck (Luscombe) went on record for low air pressure (under 100 lbs. per sq.in.), and Weick for no air pressure at all; Kurt adding that with high pressure the required pump weight must be added to the airplane weight. J. P. D. Garges (Fairchild) asked if an oil and spring shock-absorber unit for landing gears could not be used instead of air pressure. R. H. Depew, Jr. (Ludington-Griswold) replied that it could be and that Fairchild had been using such units since 1927 on their various models of airplanes. Westcott commented to the effect that a steel spring is a little heavier and more costly than air. (This ought to go in our "sounds reasonable" department.)



Proposed simplified shock strut explained by William B. Westcott of Electrol, Inc.

Gordon L. Freedman (Freedman Aircraft) raised the question of the general economics of airplane durability on rough fields as a function of the landing gear's ability to absorb shocks. Westcott had no data in reply. Kueck reported no trouble from airplanes with quite stiff gear. Another discusser cited experience with gear having 4-in. taxi travel which gave trouble, due apparently to faulty mechanical action. Peter Altman cited unsatisfactory experience with air struts for private use and asked for views on the cantilever spring type. According to Westcott, the latter is probably practical but a little heavier than the air-oil type, based on about 2,000 lbs. gross weight.

Eli E. Hayes (P.C.A.) drew attention away from the main landing gear by stating that in his experience tail wheels gave ten times more trouble. Further discussion indicated that nose wheels were even more disproportionately tagged for trouble, and in a more critical position on the airplane.

Engine Design

"Simplified Design for Personal Plane Engines" was the subject of Carl T. Doman, Vice-President and Chief Engineer, Aircooled Motors, Inc. This interesting paper is a companion piece to the one on "Simplified Design for Low-Cost Airplanes" presented last year by Alfred Marchev, President, Republic Aviation Corporation, and a supplementary paper on the same subject by A. Boyajian at the Annual Meeting last winter. As pointed out by the author, the engine is still the biggest single-cost item in the airplane. In the effort to reduce this cost no part of the power plant can be eliminated from close scrutiny. (For complete text see page 29.)

Discussion

On his toes again to start the discussion, Gwinn questioned how to get the best distribution of fuel charge. Doman stated that the distribution is definitely better with two carburetors. He is also inclined to favor separate jet cooling for the various cylinders. Gwinn came back with "How about liquid cooling, with the possibility of getting the power out of a smaller engine?" Doman: "Might be a good approach."

F. T. Kurt (Grumman) was concerned about engine noise, especially with a submerged engine. Doman: "What's to make all the extra noise in a submerged engine?" (See discussion in preceding session.)

George H. Tweney (University of Detroit) said: "What do you think of two-cycle?" Doman: "Work covered in the S.A.E. paper by John Oerli shows great possibilities for a two-cycle engine of the opposed piston type. There is also a possibility for two-cycle engines incorporating sleeve valves such as developed by Skinner Motors in Detroit."

M. R. Balis (Bendix) maintained that carburetors for aircraft require more accurate setting than for automobiles, and that an injection carburetor minimizes danger of both icing and vapor lock. Doman: "Although not disparaging fuel injectors, why is an aircraft engine so different that it must have a $70 carburetor? Flight experience is the real test." Peter Altman (Consultant) asked: "How would you minimize starting troubles?" Doman: "An adequate battery; 60 amp. for 200 hp. Fuel injection would also help. But injectors will compete economically with carburetors only on engines of about 400 cu.in. and up." Lane (ERCO): "Since so much has been

said about the cost of carburetors, why is it that the present fuel injection engines cost more than the carburetor type? This, in fact, is the reason we are not using fuel injection on our production airplanes." The speaker asked one of the fuel injector men to reply—he mentioned that the present price of injectors was too high but will probably come down.

Richard Depew and others put in a good word for battery ignition. Leslie Trigg (Sensenich) came out in favor of testing the engine and propeller as a unit. Gwinn asked if an engine could be designed to run without the fly wheel action of the propeller. Doman: "Yes, the Seabee engine will do it. Rough operation often comes from the aerodynamic interference of the propeller."

In answer to further questions Doman maintained that oil cooling is more of a problem than cylinder cooling for the larger engines, especially if fan-equipped. On the Seabee engine of 200 hp. at 2,600 r.p.m., the fan consumes 8 hp.; oil consumption 1 pint per hour. Thomas Cotton (Westinghouse) asked for weight data on this engine. The data were given as: Engine with normal equipment—400 lbs. fan, and cooling ducts 28 lbs. Extension shaft and supports, 32 lbs. Miscellaneous, 10 lbs. Total, 470 lbs. Doman further recommended planetary gearing, on which they couldn't measure the power loss, and hydraulic valve lifters for efficiency and quiet. Chrome-plated pistons were found to be not worth-while. Speed of cranking should be at least 50 r.p.m.

John H. Geisse (C.A.A.): "About what would you say is the cost of a major overhaul?" Doman: "Too much." He recommended major overhaul at about 600 hours; spark plugs 100 hours; and piston rings at possibly 300 hours.

In answer to questions about the use of automobile fuel, averaging 10 cents cheaper than aviation gas, the author contended that most of the difference is in distribution costs, but held the opinion that we will all eventually use the same gas. (Certainly this would help solve the problem of distribution also.)

A voice: "Did I understand you correctly that you can make engines today to sell for $4.00 per hp.?" Doman: "I can't answer that without a slide rule." (Here a member of the audience promptly handed him one.) Doman (after a quick manipulation), "The answer is yes, for a lot of 5,000 engines of a size developing approximately 200 to 215 hp., but not with a $70 carburetor."

The meeting then adjourned.

Utility Symposium

The final session, the evening of June 14, was devoted to a symposium on increasing the utility of personal aircraft. At the dinner preceding the symposium, Grover Loening, Aircraft Consultant, National Advisory Committee for Aeronautics, introduced the subject with an inspiring address, of which mention has already been made earlier in this paper. Continuing in Mr. Loening's words, "To perfect the picture then, after we have made our planes so quiet that no one will object to them and can therefore have landing places right in the heart of communities we want to get to, and after we have arranged to set up those landing places with take-off aids and landing aids so that they do not need to be so large, there remains the problem of once we are in the air, how useful is this vehicle?"

To provide a favorable answer to this question the following desirable improvements were recommended in addition to noise reduction: mechanical or rocket aids for take-off; ground equipment for shortening landing runs, perhaps similar to that of a naval carrier; cruising speed of at least 150 m.p.h.; a simple radar device for detecting obstructions within a 10-mile range; high lift devices and side-wind landing gear. In closing, he predicted that with such improvements, one-half million private planes would be by no means unreasonable.

The symposium proper, under the chairmanship of George H. Tweney, Acting Director, Department of Aeronautical Engineering, University of Detroit, then got under way with the following four papers (here condensed), each approximately 15 min., presented without interruption.

Improved Performance

Walter Jamouneau, Chief Engineer, Piper Aircraft Corporation. The private market is still uncertain and development must be slow to assure a sound future. The major factors are safety, initial cost, operating cost, and means of using in thick weather. The airplane is expected to be useful only for trips of several hundred miles (perhaps subject to question). As cleaner aerodynamic designs are developed, drag control becomes more important by either flaps or air brakes. (Why not both, flaps being preferably designed for lift rather than drag?) The high rate of climb is important, to reduce the hazard from gusts during take-off. The airplane should maintain an approximately level attitude for all conditions of flight. (The latter would appear quite difficult for either maximum climb or steepest glide, considering that the angle of attack is the difference between the airplane angle and the flight path slope.) Arguments often heard for high-wing loading seem dangerous and unsound. Ability to fly slowly is particularly important after dark. The landing procedure should be simpler, not necessarily using tricycle gear, but in any case with no pitching, floating, or ground looping.

In general, the speaker felt that the greatest gain would be realized by increasing the speed range, but implied that most of such improvement should be in the direction of reducing landing speed, which would make landing easier and safer, reduce insurance and repair bills, and generally encourage more widespread airplane use.

Design and Detail Design

Ralph Harmon, Staff Engineer, Beech Aircraft Corporation. Improvement can be furthered greatly by simple application of known features and devices:

(1) High-wing loading obtained by lift-increasing means while maintaining the landing speed in the neighborhood of 50 m.p.h. maximum.

(2) Tricycle gear with wing close to maximum lift when nose wheel is just clear of ground.

(3) Long shock-absorber travel.

(4) Main wheels not too far aft of rearmost c.g.

(5) Nylon tires with improved design for better flotation.

(6) Long wheel base desirable.

(7) Cleanness of design.

(8) Increased take-off thrust, 2,000 r.p.m. maximum recommended for the propeller in take-off.

(9) Simple and effortless access. Interior easily cleaned.

(10) Baggage access from inside or outside.

(11) Noise under 93 db. aided in part by low-velocity ventilating air.

(12) No instruments or controls that interfere with vision or pilot movement.

(13) Airplane to be sold with complete equipment installed at factory.

Airports and Services

Elmer Haslett, President, North American Airport Corporation. Any improvements, whether in safety, performance, economy, or comfort, will help promote sales. Present utility is generally too low. We cannot expect a man to be satisfied to own a car that he uses only to drive around a track for an hour or so on week ends. Real utility depends largely on the character and distribution of airports. The airports should feature friendly, efficient service by which maximum utilization and enjoyment of the purchaser's investment in personal aircraft may be had

N.A.C.A. physicist Th. Theodorsen traces most noise to propellers.

The principal commodities in which the flying public is interested will be time-saving and personal service. Each individual flier is important and needs personal attention, as illustrated by methods recently introduced at Westchester County Airport. The service there includes prompt, efficient attention at the field to all the flier's needs, plus transportation into town, all paid for by a flat landing fee of $1.00. A 3-hour trip from New York City, including 1 hour of flight instruction, costs $12 and records show that 95 per cent of persons making these trips have become steady customers.

Operating Costs and Utility

Neil B. Berboth, Development Division, Fairchild Engine and Airplane Corporation, N.Y. A general formula has been developed for computing the operating cost of airplanes varying in size and performance capabilities. (Copies of the complete paper, containing the formula, may be obtained from the author on request.) A basically encouraging statement may be made as shown by application of the formula. Even with the high costs prevalent today, the private-owner airplane is capable of producing more passenger-miles of travel per dollar than any other form of transportation, bar none. The only catch is that the required investment is greater. The reason for this good showing, of course, is the airplane's greater speed, making it possible to cover more miles while spending the same dollar. Yet, from a standpoint of dollars and cents for the average prospective plane flying no more than say 200 hours per year, the airplane is uneconomic and inefficient. Admittedly, this is a difficult problem, but it is not insurmountable. Four typical airplanes, each normally four-place, have been picked to cover a present price range from about $5,300 to $11,000. Although hypothetic designs, these planes represent what can actually be produced today. One design with an estimated selling price of $6,763 is taken for further analysis as probably the best overall buy of the four, with a pay load of 718 lbs., cruising speed 153 m.p.h., range 750 miles, and having an operating cost of $0.146 per mile at 20,000 miles per year, or $0.066 per mile at 50,000 miles per year. It is estimated that if 100,000 units of this design could be produced in a period of 2 years, the selling price could be reduced to $2,860, a substantial reduction, but still high in initial cost compared with the average automobile. Hence, a sale of 50,000 such planes per year seems hardly a reasonable expectation unless utility is substantially increased. A better airplane is one means to this end, encouraging more and better airports, which in turn will stimulate more airplane demand. Then we will be able to deliver the airplane the consumer wants for the price he wants to pay, but it may take longer than anyone here is thinking right now, certainly not tomorrow afternoon.

Discussion

Entering the wing-loading contest between Jamouneau and Harmon, J. M. Gwinn, Jr. (Consolidated Vultee) came out generally in favor of slow speed capability.

Peter Altman (Consulting Engineer): "An ordinary car driven 15,000 miles per year runs close to Tweney's estimated operating cost of half the purchase price in a year."

Berboth: "The larger and more costly airplane runs less proportional operating cost."

J. F. Haines (Aeroproducts): "There ought to be a relation between wind speed and safe minimum airplane speed." Harmon: "Depends largely on the type of landing gear and other design details. The ship with a good tricycle landing gear is usually safer landing at reasonable speed." Jamouneau: "If you really insist on a fast landing you can land down-wind. My own ideal is between 30 and 40 m.p.h. air speed." C. N. Sanford (Iowa State College) expressed surprise at no mention of the roadable-type airplane, but Harmon thought that the object of such a plane would be attained by a change in our way of life, including decentralization of both industry and homes. Gwinn: "All I want to say is that we don't know yet how to make a good airplane alone, much less a roadable airplane."

On a question as to the need for a long wheel base, Fred E. Weick said that it was desirable but difficult to have a long wheel base with a tricycle gear on single-engined tractor airplanes. He pointed out that with a pusher arrangement or a multiengined arrangement without an engine in the nose of the fuselage it is relatively easy to obtain a satisfactorily long wheel base. (What about the very long wheel base of the conventional landing gear?)

F. T. Kurt (Grumman) precipitated considerable discussion on Haslett's landing fee by reporting unpleasant reaction to it. Haslett: "It is really a service fee but in the form of a uniform landing fee. Criticism has been from people who do not know the service they get." Kurt: "People wanting to fly to a cocktail party won't put up with landing fees." Haslett: "You pay for your service somehow. I have to pay my bills somehow and you get your $1.00 value." Altman: "What about parking fees for your car?" John H. Geisse: "We are talking about practical use of planes." Haslett: "The more important to charge on a business basis." Gordon L. Freedman (Freedman Aircraft): "I would be glad to pay one dollar and be treated courteously." Thomas A. Knowles (Goodyear): "Taxes like those on sales and on gasoline have been comparatively easy for agencies of Government to collect and I am wondering whether, if the landing fee is allowed to start, it might not sweep the country in similar fashion." Haslett: "It is not recommended except where necessary to balance the books at the larger metropolitan airports, where high land costs would otherwise rule out private flying in favor of other sources of revenue flying."

Altman questioned the requirements for flying after dark. Jamouneau: "This is very important. The air is smoother; it is beautiful, interesting flying. An improved airplane and airport lighting are both needed, but particularly slow flying ability." In further corroboration of the latter, Kurt pointed out that impact is proportional to V^2.

An unidentified discusser asked "Why be so concerned about costs of what you cannot even deliver?" This apparently innocent remark brought forth a final comment from Jamouneau: "We are bending every effort and missing no opportunity to give them (our customers) more for less. Most people would go without shoes if they cost $100 a pair, and most people will continue to go without airplanes if they cannot buy them for a price that is obviously worth-while."

And so ended another annual light-plane meeting.

Plan to attend the I.A.S. Air Transport Meeting in Washington, D.C., on October 24, 1946

The Pilot and the Controls

WOLFGANG LANGEWIESCHE*

Kollsman Instrument Division, Square D Company

Introduction

Flying could be much easier and instruction could be rationalized if the controls of the airplane could be more closely adapted to the purposes for which the pilot actually uses them in flight.

What are these purposes? There exists a mental picture of airplane control which is based on analogy to the automobile and therefore seems convincing. According to this picture, the airplane is steered up or down by raising or lowering the nose with the elevator. It is steered right or left by turning the nose with the rudder. It is maintained in lateral balance by banking it with the ailerons. Its speed, for any given flight path, is determined by throttle.

This mental image is essentially meaningless. When those four controls are on a stable airplane and when that airplane is in free flight, flown by a human pilot, then there occurs a peculiar shift in the scheme of *what* controls *what*. In fact, it then becomes a question just what are the respects in which flight must be controlled; furthermore, the controls assume certain functions beyond the narrow function of control.

The Essential Functions of the Controls

The *elevator*, by determining the angle of attack, becomes the *speed-control*. It is true that in curving flight a given elevator angle results in a lower angle of attack, and a given angle of attack in a higher air speed. But even in curving flight the only effective speed control is by elevator. As for up or down slope of the flight path, it is true that an increase in up-elevator deflection usually results in a more upward path. But this effect is not reliable enough to make the elevator a flight path control. The pilot's concern is often with situations in which more up-elevator results in a more downward path—for example, the slow glide, the stall, and the spin.

In a zoom, a landing flare-out, or a landing the pilot uses the elevator as an outright flight path control. But those are special *maneuvers*, as contrasted to the pilot's primary job—the establishment and maintenance of *steady flight conditions*. They involve conversion of kinetic energy to altitude and, therefore, rapid deceleration. While the pilot may be mainly interested in the by-product of elevator manipulation, the change of flight slope, he cannot help getting also the main product, the speed reduction.

As for the *throttle*, *it* turns out to control the *slope* of the flight path. In a perfectly stable airplane, throttle cannot affect air speed, since the angle of attack is wholly determined by elevator setting. In most of our actual airplanes, the propeller slipstream changes the trim, so that an increase in throttle actually makes the airplane slow down. Thus our airplanes actually overdemonstrate the point that the throttle is not a speed-control.

As for the airplane's *attitude*, nose-up or nose-down, it turns out to be an item that is not controlled. The nose is allowed to ride wherever the combination of angle of attack and flight path makes it ride.

The subject of rudder and aileron, right-and-left control, and lateral balance is exceedingly intricate, but fortunately the pilot's concern with it can be largely described by dealing with first approximations only—especially if we disregard the problem of the spin. Here again the automobile analogy is meaningless. The *turn* is determined not by rudder but by the *angle of bank*. Thus, if the airplane can be said to have a right-and-left control, the aileron is it. The bank is controlled by aileron in an interesting manner to be described.

Lateral Balance

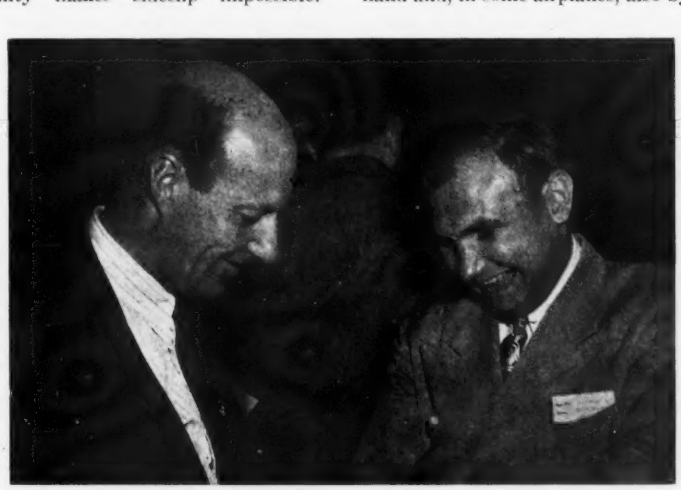
Lateral balance, often supposed to be controlled by the ailerons, turns out to be, ideally, an item that is *not controlled*. In the first approximation, when the bank is fixed and the air speed is stabilized, the airplane's weathercocking stability makes sideslip impossible. Hence, the rudder is ideally an unnecessary control. In most of our actual airplanes, however, lateral equilibrium is often upset and slideslips or "skids" are produced by disturbances of a secondary nature—the so-called "torque" and the so-called "aileron yaw." Hence, in our present airplanes the rudder must be used to aid the directional stability in "keeping the ball centered," and the *rudder thus becomes the lateral balance control*. The Ercoupe and the Skyfarer have proved, however, that the airplane can do its own correcting for these disturbances. As a balance-*maintaining* control, the rudder is therefore unnecessary not only ideally but right now and here; there is no longer any excuse for bothering the pilot with torque-correction and the whole fetish of "coordination" between stick and rudder.

Now the pilot may still want to produce lateral *un*-balance, largely in order to get sideslipping motion, as for a cross-wind landing on a conventional landing gear. This is a legitimate function of the rudder, which may thus also be called *sideslip control*.

Those are the essential functions of the control. If the pilot is to be given what he needs, we must give him, as nearly as possible, an airplane in which speed, path angle, angle of bank, and perhaps angle of sideslip can each be controlled consistently by its own control and which responds to that control only.

The Controls as "Feelers"

In addition to their function as *controls*, however, the handles and pedals by which the pilot has a hold of his airplane have another function. They also serve, or should serve, as flight *instruments*—instruments that the pilot reads by feel and deep muscle sensing rather than by eye. In our present airplanes this function is well developed in the case of the elevator, which serves not only as a speed control but also as the pilot's *speed-feeler*. When the airplane is flying slowly, the pilot knows it by the forward tugging of the stick against his hand and, in some airplanes, also by the



Messrs. Kurt and Weichsel proved that the discussion of Wolfgang Langewiesche's paper was far from dull.

Presented at the National Light Aircraft Meeting, I.A.S., Detroit, June 13–14, 1946.

* Research Pilot.

backward position of the stick. This is the most important clue; is more reliable than nose attitude, wind noise, engine noise or aileron feel; and is more insistent than the air speed indicator, which tells its story only if the pilot remembers to look.

In the case of the *rudder*, this feeler function is fairly well developed in some of our best multiengined airplanes in which the essential function of the rudder—production of intentional sideslip—is well worked out. In such airplanes the pilot knows—at least for flight at low angles of attack—that he is not sideslipping when he is not holding rudder pressure, and, inversely, he knows that any foot pressure he feels himself holding means sideslip. In most of our present small airplanes, this feeler function of the rudder is less well developed, the rudder having to be used to *prevent* sideslip as well as to cause it.

As for the *throttle*, it has no feel in our small airplanes, but in high-powered ones artificial throttle feel is frequently introduced by "gates" and throttle stops. That our present throttles do not always supply enough "feel" of power is often proved in instruction practice, when students who have made a simulated forced landing approach try to climb away on only half throttle. The lack of throttle-feel is no serious problem because engine noise supplies a substitute. In the case of a radically soundproofed light plane, interesting mental confusions have been reported because of the absence of sufficient power sensing.

As for the *ailerons*, this feeler function is completely absent in our present airplanes, and it will be shown that it would be desirable to develop it. Thus we must add to the requirements stated above: if the pilot is to be given what he needs, we must give him an airplane in which speed, path angle, angle of bank and sideslip are continuously and unmistakably signalled to him by the position and pressure of the respective controls.

Problem of Elevator Control

What kind of elevator control does a pilot need, in view of the elevator's double function as speed-*control* and speed-*feeler*? First of all, stick *forces* must not only be stable but strong—strong relative to control friction and strong relative to the pilot's muscle. The *gradient* of stick force should be steep. The more rapidly stick forces increase as the speed departs from trim speed, the more useful is the elevator in both its functions. In some of our present small airplanes, the stick force is so light and increases so slowly as speed falls off that the pilot may apply what to him, subjectively, is constant back pressure, and yet his hand and arm may gradually creep back and stall the airplane. A good elevator—for a private airplane—gives the pilot the feeling of sitting in a deep, secure groove, out of which he can get only by conscious muscular effort; this frees his conscious attention for much other work while he is flying at his trim speed and forces attention back to speed when off trim speed. Such an elevator will, of course, "load up" during a steep turn. But that only serves as a much-needed reminder for the pilot that the turn involves an approach to stalling angle of attack. A small private airplane need not be comfortable to fly in a steep turn, and a light elevator is no advantage. In airplanes that cannot stand high g's anyway, the problem of excessive stick force per g does not come up.

"... and so on, far into the night." Informal discussions lasted long after sessions adjourned.

Stick Position

Stick position, too, should not only change in a stable sense—backward for slower speeds—but should change widely. Any appreciable speed change should require a noticeable motion of the pilot's hand, a noticeable crooking of his elbow. Stick position should add its speed signals to those furnished by stick pressure, because the position signal is easier for the pilot to read. Stick pressure alone is deceptive because the pilot lacks a fixed reference value. Five pounds of stick pull may be needed to hold a normal glide with the airplane trimmed for cruising; but just how much pull is 5 lbs.? During an approach, for example, the pilot's arm is bound to tire. He may relax his pressure and let the airplane speed up, or he may overcompensate and slow the airplane up. In a tense situation the pilot tightens up and may stall, not from a conscious, if mistaken, desire to use the stick as an up-and-down control but from a purely automatic fear reflex. The same reflex makes pilots sometimes pull back on the throttle during a difficult take-off. If the pilot has one hand on the throttle, in a fixed position with reference to the airplane, then the fixed throttle hand serves as a reference point for the moving stick hand—not, of of course, rationally and by vision but unconsciously by deep muscle-sensing. The student might be told: "Now any time your stick hand is further back than your throttle hand, you are flying too slowly." Thus, large stick travel would aid in rationalizing flight instruction. The beginner naturally thinks about control manipulation in terms of movements rather than of pressures. The old bromide, "Now I'll do the maneuver and you follow me through on the stick," which is meaningless in most present airplanes for most maneuvers, would take on meaning.

The most important requirement regarding elevator control is *consistency*. The elevator being the speed control, it should control speed faithfully and should be the *only* control affecting speed; it being the speed-feeler, a given stick pressure and stick position should mean one speed and that speed only. In almost all our airplanes the throttle also affects air speed in the reverse sense already mentioned—a given stick position and stick force produce a lower air speed with power-on than with power-off. This effect, the change of trim with change of power, is probably the biggest single fatal danger in private flying. It should no longer be tolerated in so-called personal airplanes.

Causes of Accidents

The accident record shows that a large proportion of all fatal accidents involves a stall in turning flight with power-on. It is often inferred in safety-education campaigns that the turn is dangerous because the centrifugal force of the turn loads the airplane down with additional weight, as it were, and thus increases its stalling speed. This analysis seems to miss the point. First, it does not explain why these accidents do not happen often in turns with power-off. Secondly, the stall is a function of angle of attack, not of speed. Angle of attack being ideally a function of elevator deflection, no particular caution should be required in turning flight to keep from stalling. On the contrary, an airplane actually derives safety from turning. The damping of the pitching motion involved in a turn tends to make the airplane trim, for a given stick position and stick force, at lower angle of attack in turning flight than it would trim with the same stick position and stick force in straight flight. Beyond this, the direct effect of pitching motion on lift coefficient is an

additional safety factor, especially in comparatively slow airplanes in which the rate of pitch is necessarily higher for a given angle of bank than in fast airplanes. It seems, then, that the blame for these stalls during turns with power-on should be placed rather on the effect of power-on trim and stability. This effect falsifies the meaning of the signals that the pilot receives from his elevator, so that elevator pressure and position fail to warn him of the high angle of attack that, in fact, exists.

Rationalizing Instructions

Change of trim with change of power also makes it impossible to label the controls—a thing that we need to do in order to rationalize flight instruction. Any kitchen range tells its user which way is hot, and the user can at worst burn his dinner. It is a startling fact that in our present flight instruction we never tell the user which way is up and which way is fast, and in an airplane the customer can break his neck! But as long as each power change affects the air speed and, hence, necessitates manipulation of the elevator, neither the student nor even his instructor will readily grasp the essential functions of the controls.

As an example of how a labeled, consistent elevator and throttle would simplify flying, consider the pilot's biggest problem—getting down. The business-like way is to approach at slow air speed with partial power. With consistent elevator control we could tell the student: "Now reduce your speed with your stick. Now hold this same stick pressure and stick position and work your way down with your throttle." But with most present airplanes, only the more sophisticated pilot can make a good power approach. The beginner cannot keep control of his speed as he changes power.

Problems of Throttle Control

The most striking thing about the throttle, considered as a flight-slope control, is that this control will quit when the engine quits. Then, the pilot must land immediately on any field available. In making this extra-critical approach, he lacks the one control that can effectively regulate on approach! Thus *two separate risks are compounded into one risk of prohibitive magnitude.* To many pilots the stunt of making accurate approaches without using the flight-slope control is almost the essence of all flight skill, and an absurd amount of flight activity is centered around it. It is as if the bulk of all automobile driving consisted of speeding up to 60 m.p.h., and kicking out your clutch so as to coast to a stop at a predetermined spot—instead of using the automobile.

We should admit that the power-off spot landing simply cannot be done with the sureness the dangerous situation (emergency landing) requires. True, the glide angle can be influenced by what one might call "speed tricks,"—mushing, dumping, diving against the flaps. But these tricks are hard to learn and are inherently dangerous, especially in rough air, and pitifully ineffectual. The sideslip, which is effective, cannot be used in two-control airplanes. Moreover, it has been so deemphasized by Government edict that many pilots cannot do it well.

According to present flight-instruction theory, the pilot is supposed to make his power-off approach by "judgment." Crudely speaking, if he will only start his final approach at the correct point, he is bound to come down at the desired spot. In the first place, few pilots can actually develop sufficient judgment. The terms "overshoot" and "undershoot" show what is involved; it is a one-chance judgment, as in shooting. Once the pilot has made his final turn, he has shot his bolt. In the second place, unpredictable wind gradients, updrafts, and downdrafts may nullify even the best judgment.

We should forget all the elaborate culture, the endless practice, the flight tests, the trick approaches, the pride in one's judgment, the aeromedical emphasis on visual perception, etc., which has grown up around the *non*functioning of the machine. We should fix the machine instead. What the pilot needs is not a way to *shoot* himself toward a spot by *one-time* judgment but a way to *steer* himself down by *continuous* judgment, correcting his errors as they become apparent.

It is true that engine failure is becoming more and more improbable, so that throttle will normally function as flight-slope control. But as long as engine failure is still possible, it will worry the pilot. And the nervous strain on him depends not only on the probability of engine failure but also, in an irrational way upon the time during which this probability must be contemplated. Few private users of the airplane are tough enough to take it, and too many do all their flying within sight of the airport.

Glide control, then, is a task we cannot evade much longer. An airplane without glide control is like an automobile without brakes. We are stultifying our thinking by simply calling the throttle a throttle and being satisfied when it works as throttle. We should call it what it is, "the flight-slope control," and make it work as such. The pilot will always push on that handle when he is undershooting and pull on it when he is overshooting—even now, even with the engine dead. We should see to it that these reflex actions produce results. When the throttle can no longer vary the thrust from zero to plus x, it should still be able to vary it from zero to minus x. As you pull the lever back beyond the "throttle-closed" position, it should start putting on drag.

A drag device similar to a dive brake, putting on pure parasite drag, would have the advantage that it would produce precisely the effect needed—that is, a change of flight slope without change of angle of attack or air speed. Such devices, however, seem awkward because they require large surfaces if they are to be effective. A drag device that works on the induced drag by breaking up the spanwise lift distribution with spoilers has the advantage of great effectiveness, since in the situation in which the pilot needs such a control most—the slow glide and the landing flare-out—the induced drag is more important than the parasite drag. Spoilers have a disadvantage, however—their operations increases the angle of attack for a given air speed. This produces a "sinking" effect, which leads to confusions, and it may disturb the desired straightforward characteristics of elevator control. Systematic flight research in this field is badly needed. While spoilers are well explored as to their effect upon the wing section on which they are mounted, they are almost unexplored as to their effect on the entire airplane in free flight.

Problems of Rudder Control

If the idea is accepted that the rudder is essentially a control to produce sideslip, the desired rudder characteristics

"Information, Please." A general view of the utility symposium with Elmer Haslett urging better service for private pilots at airports.

follow logically. Rudder forces should be extremely heavy, and the force gradient should be extremely steep. In airplanes in which the rudder must be played to maintain lateral balance against the disturbing effects of "torque" and "adverse yaw," too heavy a rudder would make for flying fatigue. But then, the more important the lateral balance function of the rudder is in an airplane and the lighter the rudder forces must consequently be, the less desirable are the characteristics of that airplane. An airplane with strong adverse yaw effects and a light rudder is undesirable on two counts. One, it masks the essential role of the rudder, since the use of the rudder in every turn leads the pilot to believe that the rudder is the turning control. This belief may in an emergency result in a badly skidded turn and a spin. Two, the lighter the rudder is and the greater its activity during routine maneuvers, the larger are the errors likely to be which the pilot makes in his use of the rudder and the more difficult, therefore, is the problem of training.

At this point, a general observation may be in order concerning the entire subject of the pilot and the controls. *The difficulties of flying seem to be only about one-tenth in the essential nature of airplane control. They seem to be nine-tenths in those phases of airplane control where the controls do not serve their essential functions.* We have suggested that the fatal danger of flying is largely caused by deceptive elevator control—by the fact that power, as well as the elevator, affects the angle of attack. We have seen how the disproportionate nerve strain of flying is largely caused and how the entire art of flying is deflected into the sterile channel of forever shooting landings by the fact that our flight-slope control quits when we need it most. Now, with the rudder, we see how the enormous and tedious training problem of stick-rudder "coordination" arises simply from the use of the rudder for a job—maintenance of lateral balance—which is essentially unnecessary, since an ambitiously designed airplane can do this job without pilot help, by virtue of mechanical coordination or its own weathercocking stability and damping. We shall suggest presently that the whole problem of blind flying and bad weather is tied up with insufficiently elaborated aileron control.

Problems of Aileron Control

The *aileron* is the turn control, for it controls the angle of bank, and, at a given true air speed, the angle of bank determines the rate of turn. But the nature of this control differs fundamentally from that of the others. While a given elevator deflection, for example, produces a certain air speed and a certain air speed in turn can be felt by elevator position and pressure, no such relation exists between the aileron and the turn. A given aileron position will not produce a certain fixed bank and resulting turn. Thus, aileron pressure and position have no meaning to the pilot since he cannot sense from them his angle of bank or rate of turn. He can get into a steeply banked turn with the ailerons in neutral. He flies a steady right turn with the stick held to the left. In short, while the aileron does work as a turn *control*, it fails completely in that other function—as a turn *feeler*.

The reason is that, while our airplanes are stable with respect to speed and sideslip, they are not stable with respect to the banked turn. For practical purposes none of our airplanes has usable amounts of spiral stability. When left without control, none of them can be trusted not to go into a spiral dive or at least into a turn.

This fact affects the whole art of flying deeply. It confuses the beginner. He expects the conveyance to turn as long as the turning control is held over and to straighten out when the turning control is neutralized. Yet he finds this is not true. It makes it impossible to tell the student what we should be able to tell him: "When in trouble let go of all controls." Neutral elevator means that the airplane will attempt to return to trim speed. Neutral rudder means more or less neutral sideslip. But neutral aileron does not mean neutral turn.

Worst of all, this lack of strong spiral stability, and consequent lack of turn-feel, is in the last analysis what makes instrument flying too difficult for the nonprofessional pilot and thus greatly reduces the utility of the airplane in his hands. In all respects *other* than the turn, the airplane can actually be flown blind without even the help of instruments, by control position and control pressure only. Hence, with the help of instruments, outside vision is not missed after a little practice. But with aileron pressure and position meaningless, the pilot can control the turn only by the most intense, continuous attention to a turn indicator—especially in a slow airplane which has, for a given angle of bank, a high rate of turn. He cannot find—because there does not exist—an aileron position that will keep the airplane from turning while he perhaps takes his eyes off the turn indicator for a few seconds. The starting of a turn will not produce a warning change of aileron feel. Also, the meager, intellectualized evidence of a mere needle is unsupported by any physical sensing, quite unlike the indications of the air speed needle or the ball or the rate of climb, and it requires an effort of will to respond to it. This continuous act of balancing on the thin edge of the airplane's spiral instability tends to usurp the pilot's entire time, vision, and attention and to neutralize his intellectual processes. It is hard to imagine any system of simplified radio navigation or simplified traffic control which could be simple enough for the private citizen who is on "instruments" in our present airplanes that have no turn-feel.

What the pilot needs, therefore, is an aileron through which he can determine direction and rate of turn and feel his turn in the same way in which he determines and feels his air speed through the elevator. That means, of course, an airplane of strong spiral stability. Such an airplane would have to be held in a right turn, for example, by holding right aileron and would straighten out as soon as the aileron pressure were relaxed. Such an airplane could, in a pinch, be flown blind without any instruments. It would therefore be easy to fly *with* instruments.

If such an airplane had conventional ailerons, an additional burden might be placed on the rudder. In our present airplanes, in which the turn is flown with aileron on the "high" side—set for unbanking—the yaw effect of the ailerons approximately balances the natural damping of yawing motion. With aileron on the low side, rudder would have to be held "with" the turn to maintain lateral balance, which is an undesirable use of the rudder. A rolling control with favorable yaw characteristics, such as spoilers, would overcome this difficulty.

It appears that there are several ways in which a spirally stable airplane could be built. The author is content to emphasize that it *should* be built.

Plan Now to Attend

I.A.S. Air Transport Meeting

October 24, 1946

Hotel Statler, Washington, D.C.

Simplified Design for Personal Plane Engines

CARL T. DOMAN*
Aircooled Motors, Inc.

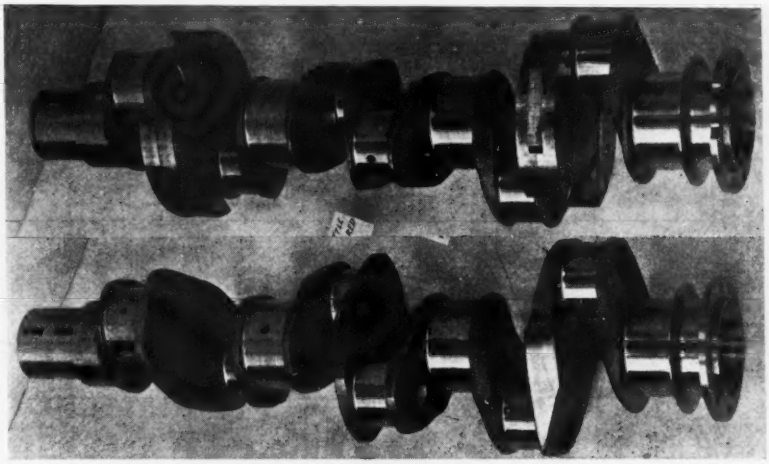


Fig. 1. A conventional style crankshaft (left) compared with a crankshaft for the 500-cu.in. engine.

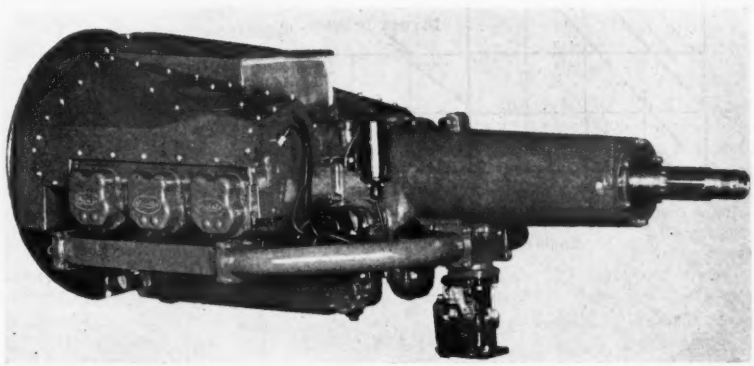


Fig. 2.

Introduction

In these days, as never before, the aircraft industry is studying ways and means of reducing costs. To the airplane maker, the engine seems to be the most fertile spot for cost reductions. Therefore, in order that the engine maker may be in a position to sell his product for less, it is necessary to consider the whole power-plant picture from a simplification standpoint.

Since the airplane manufacturer is cognizant of the highly satisfactory performance of the automobile engine, he logically suggests the use of the high-speed, small displacement power plant. This seems a simple problem to the engine designer; however, the airplane manufacturer immediately points out that it is impossible to turn the propeller at crankshaft speed, since the propeller efficiency is extremely low when turned at high speed. Furthermore, a fast-turning propeller produces a disagreeable noise. This means that it is necessary to consider some type of gearing between the crankshaft and the engine. If the engine is operating at 3000 r.p.m., the propeller would be turning approximately 2,000 r.p.m.

The introduction of the gear reduction between the engine and the propeller is quite simple in itself. However, experience has shown that the added flexibility of the gear reduction unit results in excessive torsional vibration of the crankshaft system. To remedy this condition, it is usually necessary to incorporate a means for absorbing torsional vibrations. The most common method is to use the torsional dampers, fastened to the crankshaft itself. (See Fig. 1, upper illustration.)

A cost analysis of the crankshaft incorporating dynamic balancers has shown that a power plant to sell at $3.00 to $4.00 per horsepower cannot tolerate these complicated parts. Therefore, the engine maker, for the moment at least, is forced to satisfy the performance requirements of the airplane engineer by the use of larger displacement with direct-drive propeller. Such an engine is shown in Fig. 2. This six-cylinder engine, having a 5-in. bore and a $4^1/_4$-in. stroke, develops 225 hp. without cooling fan, and 215 hp. with cooling fan, at 2,500 r.p.m., when operated on 80-octane fuel, 7:1 compression ratio.

In the future, this same basic engine, when geared, would give the performance as shown in Fig. 3. These performance figures are definitely not available today but certainly are within the realm of possibilities for a power plant of this basic design.

In order to illustrate the approach to this simplified design for a 500-cu.in. direct-drive, fan-cooled engine, it is thought advisable to consider the various sections or assemblies of such an engine.

Crankshafts

Also shown in Fig. 1 (lower illus.), is a crankshaft of simplified design. This shaft requires 3.8 hours for completely machining the forging, while the crankshaft incorporating the balancers requires 14 man-hours to machine. To this is added the labor of approximately 14 hours for machining the eight units making up the dynamic balancers. The reduction in machining time for the simplified shaft resulted from designing the forging to eliminate expensive machining operations and minor increases in manufacturing tolerances.

Inasmuch as several installations of the simplified type of engine require a long crankshaft extension, at the same time incorporating an integral cooling system for submerged installations, a certain amount of added flexibility in the crankshaft system results. Fig. 4 shows the fan, flywheel, crankshaft, and propeller extension shaft. Peculiarly, when the vibration survey was made on this engine without the cooling fan, but with the flywheel, an objectionable third order vibration of 4° amplitude was found at 2,450 r.p.m., or very nearly at the rated speed of the engine. The installation of the cooling fan,

Presented at the National Light Aircraft Meeting, I.A.S., Detroit, June 13–14, 1946.

* Vice-President and Chief Engineer.

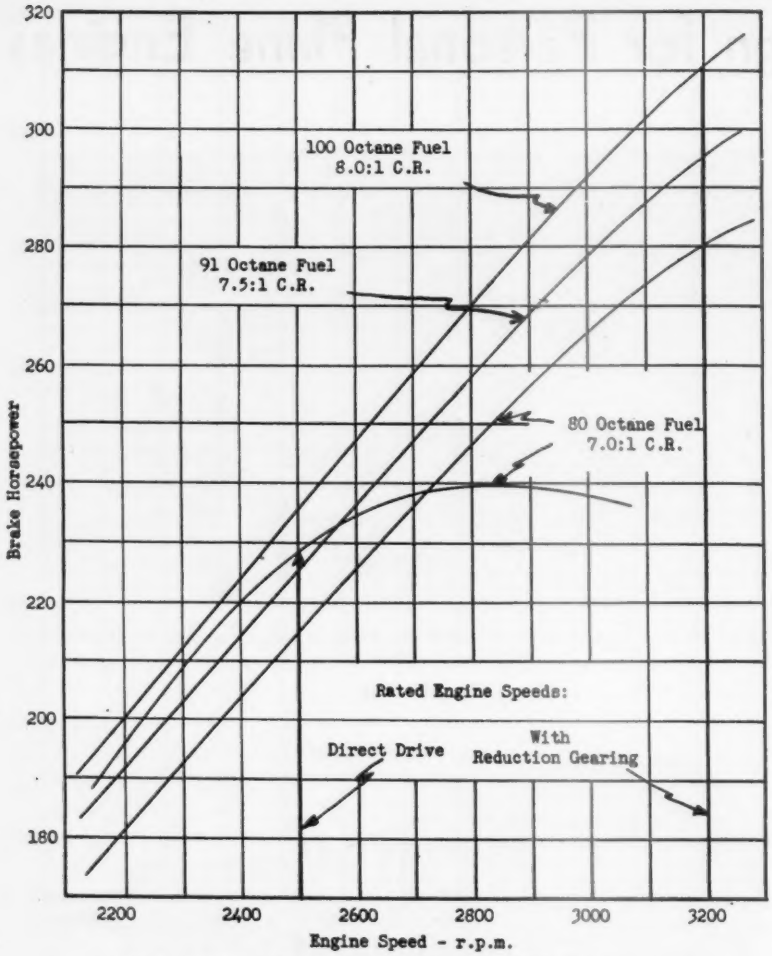


Fig. 3. Engine performance possibilities of the 500-cu.in. engine.

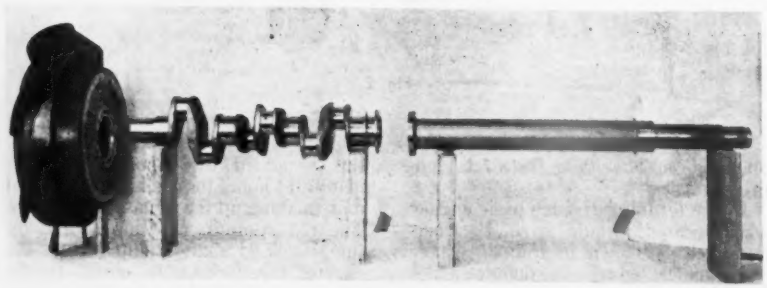


Fig. 4.

which is mounted to the flywheel on rubber bushings, immediately eliminated this serious torsional vibration at 2,450 r.p.m., but disclosed a third order of relatively low amplitude at 1,450 r.p.m. It was with this combination that the engine was subjected to and successfully passed the C.A.A. type test.

Crankcase Construction

In the endeavor to reduce weight, magnesium was considered as a crankcase material; however, experiences with magnesium crankcases during the war, in experimental engines at least, have not proved satisfactory. Furthermore, the magnesium prices offered by the various foundries, when the simplified line of engines was designed, were approximately three times that of the cost of aluminum castings. Therefore, it was decided to use one of the regular aluminum alloys used commonly for various engine castings. Recently, magnesium foundries have indicated the possibility of obtaining castings at a cost equal to or lower than that paid for aluminum castings. Future development work will determine whether or not the use of magnesium will result in satisfactory crankcases in this material.

The engine designer in the past has not appreciated foundry problems in designing the crankcases, since many complicated cores are needed. Furthermore, by properly coordinating the design with the foundry engineer, it might be possible to incorporate many green sand cores or possibly use permanent mold or even die cast crankcases. The simplified crankcase design offers great possibilities for reducing cost, since it is simple to cast and at the same time is symmetrical in the design in that it can be used for either half of the case.

Cylinder Construction

Fundamentally, the cylinder is the heart of any aircraft engine, therefore it requires and does receive the greatest amount of attention. In one of the many studies to simplify cylinder design, many types were considered. The analysis narrowed down to two distinct types, as shown in Fig. 5. The cylinder assembly shown on the left represents the somewhat conventional construction, where a forged steel barrel incorporating an aluminum muff is screwed into a cast aluminum head. The cylinder on the right shows a single aluminum casting weighing 19 lbs., into which is shrunk, after machining, a thin cast-iron liner. Analysis of the two types indicated that the unit casting could be purchased for approximately 50 per cent of the total cost of the three-piece type. As far as machining is concerned, a reduction of 50 per cent resulted from the use of the unit type. In addition to the labor and material saving, it was also found possible to use conventional iron piston rings, similar to those used in heavy-duty motor trucks. In the simplified engine there has been no compromise whatsoever in the quality of the valves or valve seats selected. The exhaust valve incorporates a two-piece construction—that is, the head of stainless steel welded to a stem incorporating SAE 3140 or equivalent plus the addition of stellite on the valve face. Experience has shown that for the inlet, the conventional type of material (namely, SAE 3140 or equivalent), without stellite, is satisfactory, providing the valve mechanism is designed so that there is no valve bounce or valve spinning under any condition of operation. Had it been necessary to use a stellite-faced inlet valve, it would be necessary to increase the price paid by approximately 200 per cent. Experience has shown on some engines that the substitution of stellite was the only apparent remedy for eliminating excessive wear on the face of the valve. This was, no doubt, due to improper accelerations or decelerations of the valve mechanism parts.

For the intake valve seat, high-grade cast iron is used, shrunk in position with approximately 0.004 in. tight at room

Fig. 5.

temperature, and rolled into position, thus eliminating the possibility of the seat dropping out of position. The exhaust valve seat uses a variation of stainless steel. This seat is also shrunk and rolled into position.

Experience in building engines for military types of airplanes has indicated that cast-iron valve guides hardened and honed are highly satisfactory. This, of course, results in a decided saving, since it is possible to purchase the cast-iron guide for approximately one third the cost of the same part if made of bronze or of stainless steel.

Valve Operating Mechanism

This engine of simplified design incorporates the hydraulic valve lifter. The use of this unit necessitates a careful analysis of the entire valve mechanism in order to eliminate any possibility of valve bounce, lifter pump up, valve spring failure, camshaft failure, etc. Therefore, close cooperation is necessary between the respective Engineering Departments of the engine maker, the manufacturer of the hydraulic valve lifter, valve spring, valve, camshaft, etc.

An analysis of the cost for manufacturing the camshaft from a conventional steel forging indicated that serious consideration should be given to the use of the cast-iron shaft, which had proved so satisfactory in the automobile industry. The steel camshaft was gun-drilled for lightness and turned between the cam lobes. The cast-iron camshaft required machining of the journals, the cams, and the gear for driving the oil pump. The cost analysis showed that while the cast camshaft cost 20 cents more than the steel forging, the manufacturing time assumed 40 per cent of that required for the forged shaft.

Lubricating System

In the conventional type of engine in the 200- to 250-hp. class, it has been considered normal practice to incorporate the dry sump type of lubricating system. This means added complications, including external tanks and an additional oil pump for circulating the oil through the cooler and filter and another section for circulating oil through the engine itself. In Fig. 6, the illustration to the right shows a conventional dual pump. On the left is shown an extremely simple pump that assumes the entire responsibility for forcing the lubricating oil through the oil cooler to all the internal parts of the engine. This pump incorporates pressed metal gears exactly the same as used in large production automobile engines. The cost of these gears, in comparison with the regular steel cut type, shows a 50 per cent reduction.

In the upper portion of Fig. 6 is shown the floating type of oil screen, exactly the same as used in hundreds of thousands of automobile engines. This screen assembly, while costing much less than those customarily used in aircraft engines, has an added advantage in that it eliminates the possibility of the pump suction picking up any metal particles lying on the surface of the oil pan.

It is normal practice to use cast oil pans, either of magnesium or aluminum. The simplified design uses a simple stamped aluminum pan, costing the engine manufacturer, from a stamping specialist, $3.50. The cast aluminum or magnesium pans cost between $14 and $20, depending upon the complexity of the casting.

Gear Trains

To best illustrate the simplification of the entire gear train, refer to Fig. 7. This shows a portion of the gears used in a 240-hp. engine designed for military service. It incorporates drives for standard aircraft generators, starters, fuel pumps, vacuum pumps, hydraulic pumps, magnetos, and tachometers. In the simplified design, only two of the gears shown are used—that is, the camshaft and camshaft gear. All others are replaced by the four simple gears, as shown in Fig. 8, from the simplified design.

In the simplified design, a simple stamped steel cover is used, costing 32 cents. This replaces the two cast magnesium housings costing $22.

Accessories

One of the most discouraging items to an engineer who is attempting to reduce costs is the amount charged by the accessory manufacturers. In some engines, if regular aircraft accessories are specified, or those accessories meeting AN specifications, it has been found that the cost of the accessories exceed the total cost of all the parts in the engine combined. Therefore, in simplified design, the engineer must, in his

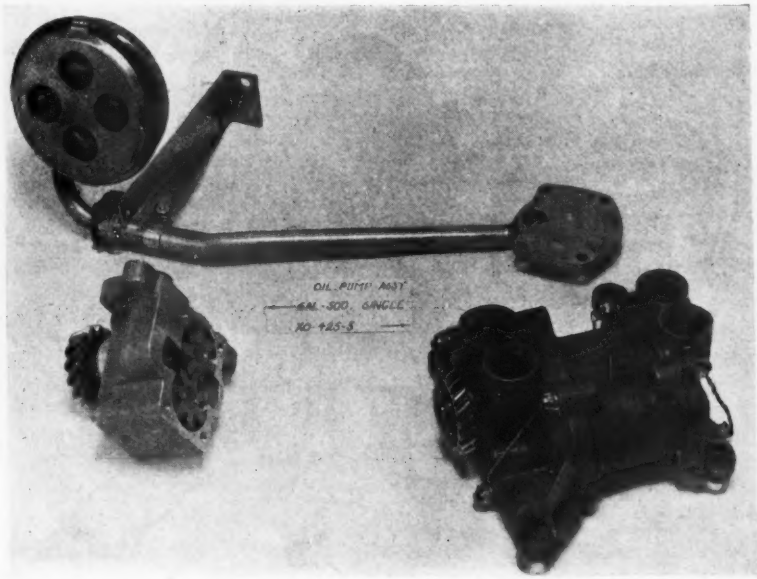


Fig. 6.

thinking, eliminate the use of any specialized aircraft accessories.

Compare the so-called aircraft accessories and the accessories of the automotive type. The regular aircraft generator costs the engine manufacturer 31 times the cost of a converted automotive type. The reason for the vast difference in the cost of these generators is the fact that the low-cost unit, other than the changes in the field winding, may be produced for one customer alone in the next calendar year at the rate of approximately 6,000 units per day.

The same type of thinking holds for the starter. Since there is no flywheel housing on an aircraft engine, an automobile starter cannot be used without certain changes for mounting.

In choosing an ignition system, from a cost, endurance, and performance standpoint, the engineer is justified in selecting the modified automotive type of ignition. The total cost of the distributors, plus coils, represents approximately one-third that of the magneto ignition.

For spark plugs, the heavy-duty type of automotive plugs, costing a few cents, has been absolutely satisfactory up to 160 lbs. b.m.e.p. However, when ignition shielding is required for certain types of radio equipment, the conventional aircraft type of spark plug is necessary. From a service standpoint, however, it has been found that the automotive type of spark plug will operate at least 100 hours without requiring any attention, then it seems to be only a matter of regapping the points.

In the selection of a carburetor, the engineer has a bigger problem facing him. He can select a more or less conventional float type of aircraft carburetor, or he can specify either the pressure-type carburetor or the fuel-injection system. To handle properly an engine of 225 hp., there seems to be little difference in cost between a conventional aircraft float-type carbureter and the so-called pressure carbureter. On the other hand, if the fuel injection system is specified, experience has indicated that, when the cost of the injection pump, throttle box, the nozzles, and the piping are taken into account, the fuel-injection system represents an increase in cost of approximately 25 per cent. From a performance standpoint, other than icing, any one of the three types seems to be satisfactory. However, there are certain savings that the airplane manufacturer may make if he uses the injection carburetor or the fuel-injection system. When he uses either of these systems, by virtue of a recent C.A.A. ruling he is able to eliminate the hot-air stove for supplying heat to the carburetor. Various estimates have been made, but it appears that the saving resulting from the elimination of the stove runs somewhere between $7.00 and $25.

The lowest cost approach to the carburetor problem, for the present at least, seems to be the use of some version of the automotive type of

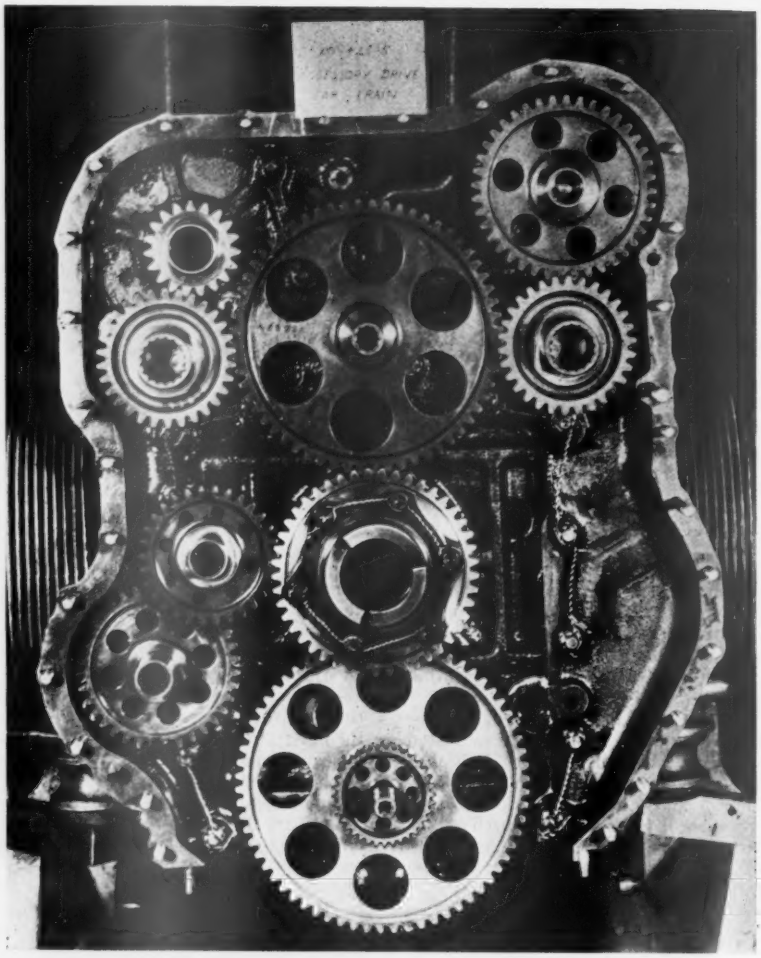


Fig. 7.

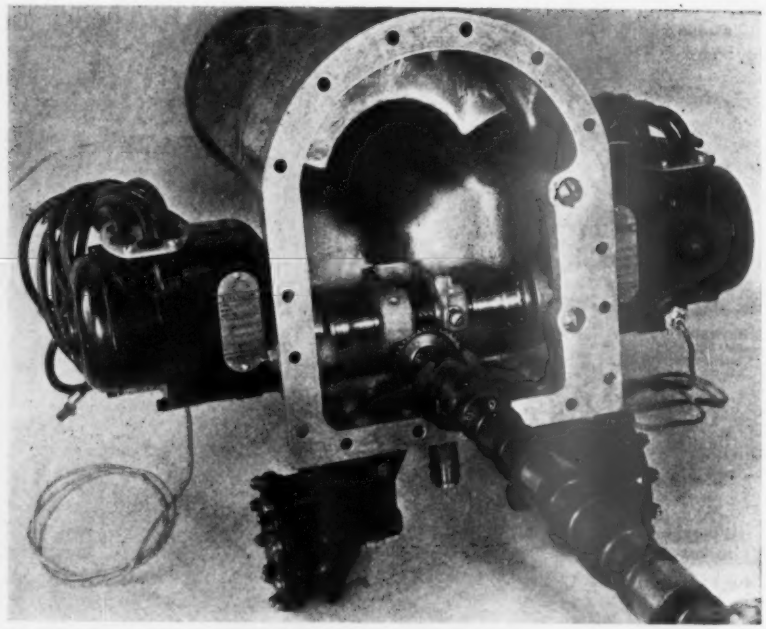


Fig. 8. Five hundred-cu.in. engine accessory drive with cam, accessory drive gear, ignition cross shaft drive, ignition coupling, and tachometer drive and driven gears.

carburetor. Two carburetors, exactly the same as used on a high-production automobile engine, were installed on a 225-hp. aircraft engine. Dynamometer tests have shown these carburetors to give the same performance as was obtained on the same type of engine from the conventional aircraft type of carburetor, the pressure type of carbureter, or the injection system. Flight tests do indicate that some means of altitude control will be necessary, since these automobile carburetors run excessively rich with increase in altitude. In order to maintain the lowest costs quoted on these carburetors, it is felt expedient to make the changes for altitude control outside the carburetor, otherwise the price would increase materially because the carburetors would then be special. As a matter of interest, the combined cost for two of these carburetors is one-ninth the price quoted for the conventional aircraft or the injection carburetor. With this potential saving, there certainly should be maintained concentrated effort to make these carburetors satisfactory for aircraft use.

Approach to Tooling

The aircraft-engine designer usually is reluctant to consider the use of stampings, since he is of the opinion that the costs of dies are excessive for limited production and the investment would not pay off. In many cases, this opinion is erroneous, since it is possible to design a part as a stamping, save weight, save on the piece price, and also save on the tooling. As an example, the stamped timing gear case represents a die cost of $7,505. With this set of dies it is possible to produce a piece ready to go on the engine at a cost of 33 cents to the engine manufacturer. On the other hand, if the same part is made in a magnesium casting, as is necessary to keep the same weight, the metal pattern would cost $3,175, plus $1,750 design time for fixtures, plus $2,200 for machining fixtures, and tool tryout $500, for a total of $7,625. Then, in addition, the cost of the casting would be, in magnesium, 4 lbs. at 90 cents per lb., or $3.60, plus 35 min. for machining labor. Many other items could similarly be shown which indicate the advisability of using stampings instead of machined castings.

Assembly and Test

Certain individuals have maintained the idea that, since an engine is to be used in aircraft, it must be built by hand, with a great deal of individual attention given it when it is assembled. This is an erroneous supposition, since—if parts are properly designed, properly machined, and properly inspected—once delivered to the assembly line they should be assembled into an engine with great speed and with a high quality, greatly exceeding that of another engine that was built perhaps from inferior tools, inspected semicarelessly, and assembled in a so-called leisurely way.

Down through the years, airplane-engine manufacturers, for some reason or another, have continued to test their particular engines in test cells, where an operator or operators observe the engine throughout its test program. This is an expensive and needless operation. The logical approach is the use of dynamometers, so located in respect to each other that the tester may go from engine to engine observing its operation through the various stages of its running-in period and final test. This means that every engine would be given the regular run-in of approximately 3 hours, followed by a full throttle test of 1 hour, during which sufficient data would be taken to show definitely whether the engine is producing its guaranteed output. Experience has shown that 3 hours of run-in, plus 1 hour of final test, is sufficient to assure the manufacturer that once the engine is installed in the plane it may be operated continuously under full throttle conditions.

The automobile engine has proved to everyone that a quality power plant can be built in a minimum time and at a minimum cost. This same philosophy must and will be followed by the aircraft-engine industry if prices are to come down from the excessive figures being quoted today. Prices of approximately $5.00 per hp. are possible today; however, because of particular design of the power plant and the relatively low quantities produced, high prices are maintained. Certainly a power plant at $3.00 per hp. is not so far away, with the reduction later on to $2.00 per hp. definitely in sight. To reach these price objectives, however, those producing airplanes and engines must have the courage to spend sufficient money for simplified engineering, sufficient money for proper tooling, sufficient funds for manufacturing equipment, and requisition sufficient quantities so the purchasing departments may buy at really low prices. The future offers interesting competition to those really interested in simplified engine design.

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The facilities of this library are available for reference study at the Institute.

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6715 Hollywood Boulevard
Hollywood 28, Calif.

This is a service and reference library for West Coast organizations. Full information as to its facilities will be sent on request.

Exhaust Pump for Engine Cooling

CARL DE GANAHL*
Kaiser Fleetwings, Inc.

Introduction

An exhaust pump accomplishes the required cooling of an aircraft engine by using the velocity energy in the exhaust for sucking the cooling air through the engine. The pump consists of a closed cowl (i.e., one having no outlet) in which the engine is sealed except for the usual inlet at the front, and one or more relatively small mixing ducts or augmenters extending from the rear of the engine compartment to a point fairly well aft of the maximum ordinate of the wing. These ducts open to the atmosphere, preferably with a divergent section of variable divergence at the outlet.

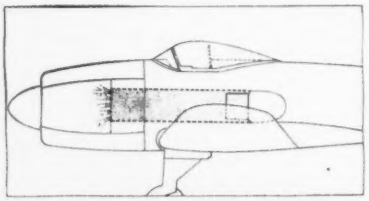
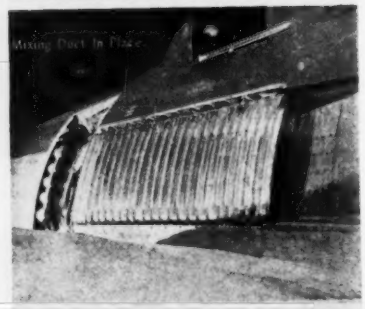
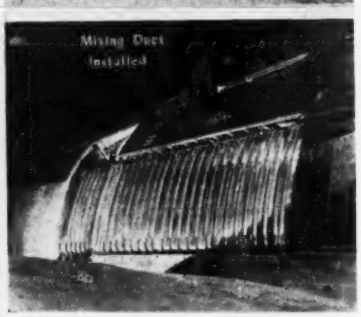


Fig. 1a.





Figs. 1b (*top*), 1c (*center*), 1d (*bottom*).

Mixing Duct Design

Two mixing ducts, one on either side of the fuselage, appear to be the most satisfactory installation for a single-engined low-wing design as shown in Fig. 1a. Figs. 1b, 1c, and 1d illustrate an actual installation. Usually it is found that the mixing duct is more efficient and easier to build if it is of constant cross-sectional area with a properly streamlined entrance into which the ends of the exhaust stacks project, stopping just short of the throat of the mixing duct.

Flow Considerations

Experiments indicate that the steadier the flow that can be obtained from any exhaust stack, the greater is the capacity of a given mixing duct area. It is, therefore, desirable to Siamese three exhaust stacks without overlap so that the flow of exhaust gas will be as nearly continuous as possible. However, this was found to be impractical, simply because of the maze of exhaust stacks required to Siamese cylinders 120° apart. It was decided, therefore, to Siamese the exhaust stacks in pairs and emit the exhaust gases at the throat or an inch or two ahead of the throat in the mixing duct.

Fig. 2 is a graph for one of the R-2800 Pratt & Whitney engines, showing the periods at which the exhaust valves are open over two revolutions of the engine. From this graph it can be determined what combinations of exhaust ports can be Siamesed into a single exhaust port without any overlap of the exhaust flow, and thus avoid interference of the flow from one cylinder with another.

For instance:

(1) Any three cylinders, 120° apart, can be Siamesed into a single exhaust stack without overlapping the exhaust valve openings.

(2) Any two adjacent cylinders in the same bank can be Siamesed into a single exhaust stack.

(3) Any cylinder in opposite banks, five cylinders apart, can be Siamesed.

The area behind the cylinders should be effectively sealed off from the rear case holding the engine auxiliaries and built in such a way that the flow of cooling air to the mixing ducts encounters a minimum of interference. The velocity energy in the exhaust gases sucks the cooling air into the mixing duct where its momentum is mixed with that of the cooling air, and is ejected to atmosphere rearwardly according to the momentum equation. Under certain conditions, it is ejected with greater momentum than is contained in the exhaust gases alone, thus producing an appreciable improvement in thrust.

Such a system of design has resulted in the following advantages:

(1) It cools the motor under all conditions of flight.

(2) Better ground cooling can be obtained under static conditions than under other methods, short of a fan.

(3) It eliminates cooling drag and delivers some thrust power in addition.

(4) It improves the high speed somewhat.

(5) It improves the rate of climb materially (calculations indicate up to 31 per cent).

(6) It is a complete flame damper (no flame can be seen from any angle at night).

(7) It improves the streamlined characteristics of the airplane and, consequently, reduces the drag somewhat. (How much has not been determined.)

(8) The exhaust pump acts as an excellent silencer anywhere forward of a 45° cone with the exit of the pump as the apex of the cone. With proper care in its location, therefore, the noise of the exhaust can be greatly reduced in regard

Presented at the Design Session, Fourteenth Annual Meeting, I.A.S., New York, January 29–31, 1946.

* Director of Research.

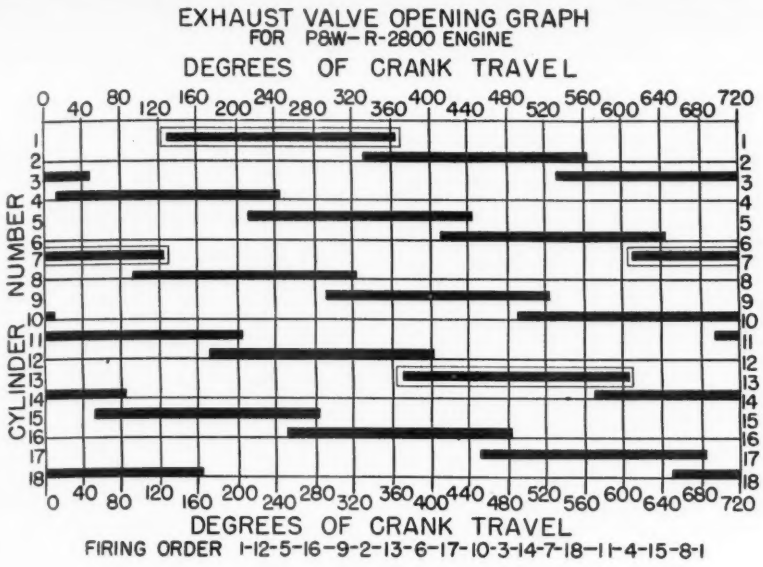


Fig. 2.

to its effect on the occupants of the plane.

Qualitatively, most of the above advantages show evidence of having been realized. The flame damping, however, is complete and perfect. Information available up to the present time is purely qualitative and, in order to understand properly the functioning of the pump and to take advantage of its highest possibilities, a careful survey must be made and quantitative results obtained. It is hoped this will be accomplished in the near future.

Installation

Difficulty was at first encountered in obtaining an installation that was mechanically and structurally satisfactory over a period of time. This problem has since been eliminated, and a satisfactory installation has been obtained without resorting to individual circular augmenters. The problem involves proper shock mounting, sufficient local stiffness, and the elimination of stress concentrations created by impact from the exhaust nozzles. Circular augmenters would, of course, be lighter and more reliable structurally, but they involve an inconvenient space problem in this instance.

The Design Problem

The design problem for proper functioning involves:

(1) A means of ascertaining the average effective exhaust velocities available at the exhaust outlet under various pressure and output conditions. These can be obtained from the manufacturer of the engine.

(2) Mixing the exhaust with the cooling air in a mixing duct. By conservation of momentum in an equal area duct, the momentum of the entering cooling air and the momentum of the exhaust gases are summed to an average momentum leaving the mixing duct.

(3) The momentum of the cooling air entering the mixing ducts is determined by the pressure drop across the engine, the impact pressure into the engine, and the pressure at the throat of the mixing duct.

(4) The pressure at the throat of the mixing duct is used as the control and is determined by the amount of divergence given at the exit of the mixing duct. For optimum results this should be a variable divergence controlled automatically from the temperature of the engine. Thus the amount of cooling air is held to just that required for cooling and no more; in which case the maximum thrust is maintained throughout all regimes of flight.

Duct End Variable Divergence

Considerable discretionary care must be used in designing a suitable variable divergence at the end of the mixing duct. Firstly, the door is fairly large, the loads are considerable, and it must be made rigid enough not to vibrate and induce fatigue failure. It cannot be opened too wide or an aerodynamic separation occurs, canceling out the diffuser effect and resulting in no reduction in pressure at the throat of the mixing duct. The amount of diffuser effect that can be obtained with a variable diffuser is, therefore, distinctly limited due to practical considerations. This means that the mixing duct must be made large enough in the first instance to carry the cooling air necessary with only a small diffuser effect at the exit, and then to close this diffuser to a nozzle during cold weather at cruising speeds in order to prevent overcooling.

These latter requirements mean that the maximum thrust that should be available at high speeds and in cold weather is somewhat reduced. As far as Army Standard Air or N.A.C.A. Air is concerned, it would be possible to design an exhaust pump without a variable divergence at the exit, thereby eliminating the necessity of a moving door, which would meet all requirements of performance without any serious sacrifice in high speed. Such an installation, however, would seriously handicap the airplane in low-powered cruising, extremely cold weather, etc., because of overcooling to an extent where proper functioning of the engine could not be maintained.

The ideal arrangement for maximum performance in high speed, climb, or cruising in cold or hot weather, would be an installation with a variable-area mixing duct controlled from the cylinder head temperature. Such an arrangement would provide very nearly maximum thrust in all regimes of flight, without excess cooling. So far, we have been unable to think of any practical

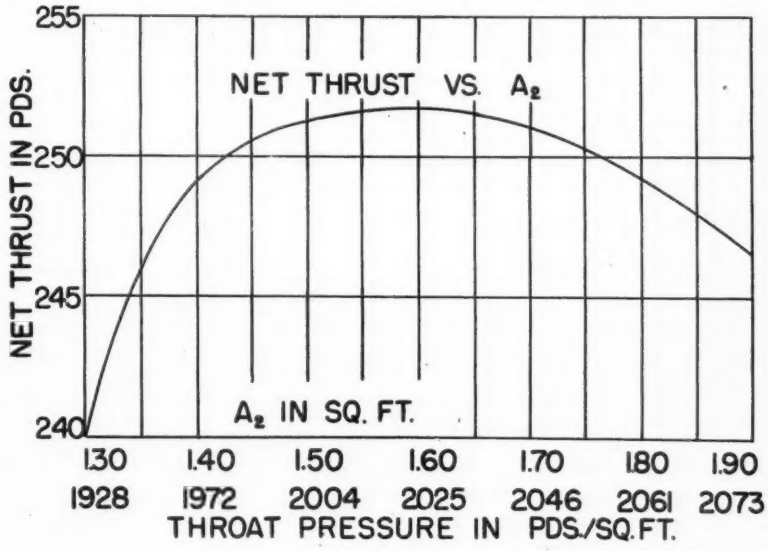


Fig. 3.

mechanism suitable to such an installation.

For the type of installations just described, an extremely simple and straightforward system of calculation has been evolved, based on theoretically correct compressible flow without resorting to any assumed approximating qualifications, such as incompressible flow. In these calculations, efficiency coefficients have been used here and there culled from other industries for similar types of flow. A quantitative survey of an existing installation should establish more clearly what these values should really be. The following is an example of the detailed calculations for an exhaust pump on an airplane with assumed typical characteristics. In particular, it is the case for climb at sea level with N.A.C.A. Air.

Example of Necessary Calculations for an Exhaust Pump on an Airplane with Assumed Typical Characteristics

Consider the following case for climb at sea level with N.A.C.A. Air.

(1) Engine brake horsepower (typical) = 2,000 hp.

(2) Calculated air speed (best climb) = 185 m.p.h. or 270 ft. per sec.

(3) Impact temperature rise = 6.1°F.

$$\Delta T = \frac{V^2}{2JgC_p} = \frac{\overline{270}^2}{12{,}000}$$

(4) N.A.C.A. free air temperature = 519° R.

(5) Temperature at engine face (T_2) [No. (3) + No. (4)] = 525.1° R.

(6) N.A.C.A. free air pressure (atmosphere) = 2,116 lbs. per sq.ft.

(7) Corresponding q or pressure rise at engine face = 88.2 lbs. per sq.ft.

$$q = P_0[1 + (\Delta T/T_0)]^{3.5} - P_0$$

(8) Use 1.25 times this for climb due to estimated propeller ram = 110.3 lbs. per sq.ft.

(9) 85 per cent of above (appears to be best experience) = 93.8 lbs. per sq.ft.

(10) Pressure at engine face [No. (6) + No. (9)] = 2,209.8 lbs. per sq.ft.

(11) Amount of required cooling air (from engine manufacturer), w'', = 27.8 lbs. per sec.

(12) Pressure drop across engine (from manufacturer) = 57.2 lbs. per sq.ft.

(13) Pressure behind the engine [No. (10) − No. (12)] = 2,152.6 lbs. per sq.ft.

(14) Temperature behind the engine = 609.9° R.

$$T_{1n} = T_2 + \frac{40\%\ \text{b.hp.} \times 550}{w'' \times 0.24 \times 778} = 525.1 + 84.8$$

(15) Total exhaust jet flow, fuel and carb. air (from manufacturer), w', = 4.125 lbs. per sec.

(16) Ratio of cooling air to exhaust flow, (r), = 6.74.

$$r = (w''/w') = (27.8/4.125)$$

(17) Pressure at exit of exhaust pump = 2,045.4 lbs. per sq.ft.

$$P_x = P_0 - aq = 2{,}116 - 0.8 \times 88.2$$

q is the impact pressure rise due to air velocity of airplane. An estimate for a is to be obtained from N.A.C.A. reports. It is made up partly from the location of the exit with respect to the fuselage and the wing. See *Pressure Distribution on the Fuselage of a Midwing Airplane Model at High Speeds*, Langley Memorial Aeronautical Laboratory, T.N. 890, 1943, giving a conservative a = 0.6. See, also, *Pressure Available for Cooling with Cowling Flaps*, Langley Memorial Aeronautical Laboratory Report, T.R. 720, giving a conservative 0.2 addition for a reasonable flap opening on final design.

Preliminary Calculations

The net results of these preliminary calculations are:

w'' = 27.8 lbs. per sec.
w' = 4.125 lbs. per sec.
P_{1n} = 2,152.6 lbs. per sq.ft.
T_{1n} = 609.9° R
P_x = 2,045.4 lbs. per sq.ft.

With these data the performance of the exhaust pump is calculated for various values of the throat pressure. That pressure giving greatest thrust is the one chosen, and the corresponding area is built into the pump. Fig. 3 shows a curve of the mixing duct area versus net thrust. The calculations below are for the point of maximum thrust on this curve. In order to give the necessary equations, the notation exhibited on Fig. 4 is used.

Final Calculations

(18) Internal area of exhaust jets (actual) = 0.323 sq.ft.

(19) External area of exhaust jets (actual) = 0.350 sq.ft.

(20) Assume a throat pressure, say = 2,025 lbs. per sq.ft.

(21) $T''_{un} = T_{1n}(P/P_{1n})^{0.286}$ = 599.34° R. (T_{un} means T uncorrected for inefficiency.)

(22) $V'' = \sqrt{KE_1(T_{t\,1n} - T''_{1n})}$ = 351.9 ft. per sec.

E_1 = 0.95 (culled from best experience).

$K = 2JgC_p$ = 12,000.

Note: $T_{t\,1n} = T_{1n} + (\overline{V}_{1n}^2/K)$. V = 60 ft. per sec. (assumed velocity behind engine).

(23) $T''_{cor} = T''_{un} + (1 - E_1) \times (T_{t\,1n} - T''_{un})$ = 599.88° R.

(24) $A'' = (w''RT''_{cor}/V''P)$ = 1.247 sq.ft.

(25) $A_2 = A'' + A'_{ext}$ = 1.597 sq.ft.

(26) Mean effective exhaust velocity V' = 2,103 ft. per sec. (from manufacturer).

(27) Compute V_3 from quadratic equation V_3 = 436.7 ft. per sec.*

$$V_3^2\left[\frac{(r+1)w'}{g} - \frac{(r+1)w'R}{K}\right] - V_3\left(AP + \frac{w'}{g}V' + \frac{rw'V''}{g}\right) + (r+1)w'RT_{t3} = 0$$

where

$$T_{t3} = \frac{T_c + rT_{1n\,t}}{r+1} = 881.10°\ R$$

and

T_c = 2,338 + $(\overline{2{,}103}^2/K)$ = 2,707° R = total temperature of jet alone.

(28) $T_3 = T_{t3} - (V_3^2/K)$ = 865.23° R.

(29) $P_3 = \dfrac{(w' + w'')RT_3}{V_3A_2}$ = 2,112 lbs. per sq.ft.

(30) $T_{x\,un} = T_3(P_x/P_3)^{0.286}$ = 857.30° R.

(31) $V_x = \sqrt{KE_2(T_{t3} - T_{x\,un})}$ = 520.6 ft. per sec.
E_2 = 0.90 if a diffuser, E_2 = 0.95 if a nozzle } (culled from best experience).

(32) $T_{x\,cor} = T_{x\,un} + (1 - E_2)(T_{t3} - T_{x\,un})$ = 858.49° R.

(33) $A_x = \dfrac{(w' + w'')RT_{x\,cor}}{V_xP_x}$ = 1.371 sq.ft. forming a nozzle, hence E_2 = 0.95.

(34) Net thrust =
$$\frac{w' + w''}{g}V_x - \frac{w'' + \text{carb. air}}{g}V_0 = \frac{31.925}{32.2}520.6 - \frac{31.528}{g}270 = 252.1 \text{ lbs.}$$

(35) Horsepower from this thrust = 123.8 hp.

* Eq. (11).

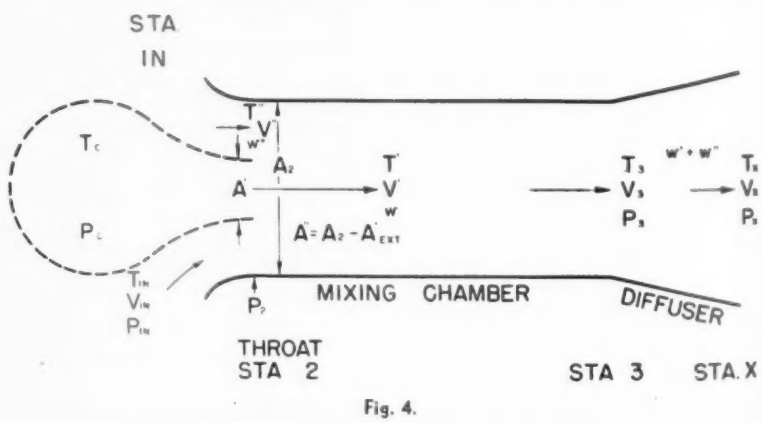


Fig. 4.

$$\text{Hp.} = (\text{Net thrust} \times V_0/550)$$

Thus, the exhaust pump gives requisite cooling and 123.8 hp. additional.

(36) Net thrust from exhaust jets alone = 238.0 lbs.

$$T_j = (w'/g)V' - (\text{carb. air}/g)V_0$$

(37) Horsepower from jets alone = 116.8 hp.

It is thus seen that the exhaust pump furnishes requisite cooling and 7 hp. more than the jets alone *without cooling*.

Formulas for Equal Area Calculations

Assume a throat pressure P.

Step 1. To find the secondary air throat area, A''.

$$A_2 = A'' + A'_{(ext)}$$

Where $A'_{(ext)}$ is known

$$T''_{un} = T_{1n}(P/P_{1n})^{0.286} \quad (1)$$

$$\left.\begin{aligned} V'' &= \sqrt{KE_1(T_{1n\,t} - T''_{un})}\ E_1 = \\ &0.95 \end{aligned}\right\} \quad (2)$$

and $K = 2JgC_p = 12{,}000$.

$$T''_{cor} = T''_{un} + (1 - E_1) \times (T_{1n\,t} - T''_{un}) \quad (3)$$

$$A'' = (w''RT''_{cor}/PV'') \quad (4)$$

$$\left.\begin{aligned} A_2 &= A'' + A'_{ext} \\ T_{1n\,tot} &= T_{1n} + (\overline{V}_{1n}{}^2/K) \\ V_{1n} &= 60 \text{ ft. per sec. assumed} \end{aligned}\right\} \quad (5)$$

Step 2.

The mean effective exhaust velocity V' (from manufacturer) = 2,103 ft. per sec., and the mean exhaust jet temperature (from manufacturer) = 2,338° R. Therefore,

$$T_c = 2{,}338 + (\overline{2{,}103}^2/K) = \text{total temperature of jet} = 2{,}707°\ R \quad (6)$$

$$T_c + r(T_{1n\,t}) = (r + 1)\left(T_3 + \frac{V_3^2}{K}\right) \quad (7)$$

or

$$T_3 = T_{t3} - (V_3^2/K)$$

where $T_{t3} = [T_c + r(T_{1n\,t})]/(r + 1)$ and $r = w''/w'$.

The momentum equation for equal areas is

$$A_2(P - P_3) = \frac{(r + 1)w'}{g} V_3 - \frac{w'}{g} V' - \frac{rw'}{g} V'' \quad (8)$$

The continuity equation

$$(r + 1)w' = (A_2V_3P_3/RT_3) \quad (9)$$

Substituting in the momentum equation, and letting

$$\frac{w'}{g} V' + \frac{rw'}{g} V'' = F \quad (10)$$

we find

$$V_3{}^2\left[\frac{(r + 1)w'}{g} - \frac{(r + 1)w'R}{K}\right] - V_3(A_2P + F) + (r + 1)w'RT_{t3} = 0 \quad (11)$$

Solve for V_3, then

$$T_3 = T_{t3} - (V_3^2/K) \quad (12)$$

and

$$P_3 = [(r + 1)w'RT_3/A_2V_3] \quad (13)$$

Step 3. To find A_x, the exit area.

$$T_{x\,un} = T_3\left(\frac{P_x}{P_3}\right)^{0.286} \quad (14)$$

$$V_x = \sqrt{E_2[K(T_3 - T_{x\,un}) + V_3^2]} \quad (15)$$

$$T_{x\,cor} = T_{x\,un} + (1 - E_2) \times \left(T_3 - T_{x\,un} + \frac{V_3^2}{K}\right) \quad (16)$$

$$A_x = \frac{(r + 1)w'RT_{x\,cor}}{P_xV_x} \quad (17)$$

Step 4. To find the thrust of the exhaust pump.

The above design will cool the engine under the stated conditions. The thrust will produce horsepower in addition.

$$\text{Net thrust} = \frac{(r + 1)w'}{g} V_x - \frac{w'' + \text{carb. air}}{g} V_0 \quad (18)$$

$$\text{Net excess hp. over cooling} = \frac{\text{Net thrust} \times V_0}{550} \quad (19)$$

Step 5. To find the thrust from exhaust jets alone.

$$\text{Net thrust} = (w'/g)V' - (\text{carb. air}/g) \times V_0 \quad (20)$$

$$\text{Net horsepower from jet, but } \textit{without cooling} = \frac{\text{Net thrust} \times V_0}{550} \quad (21)$$

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Accessories and Equipment

Analysis of Relay Servomechanisms. Herbert K. Weiss. Methods are developed for the transient and steady-state analysis of relay-type servomechanisms, with intermittently applied torque, inertia, viscous friction, dry friction, finite spacing of the controlling contacts, constant delay time in torque change, and stabilization by "flip-flop," "front-lash," and anticipatory circuits.

Solutions are obtained through representation of the motion of the servomechanism in the position-velocity or "phase" plane. In this plane, the discontinuous character of the driving torques, dry friction, delay time, finite contact spacing, and certain types of stabilizers, defines boundaries that are frequently straight lines. The boundaries divide the phase plane into a number of regions, within each of which the motion of the servomechanism is determinable by elementary means. Theorems and semigraphical constructions are developed for the rapid representation of the transient and steady-state motion in the phase plane, and simple constructions are demonstrated for converting the phase-plane plots to conventional time plots.

Guided by phase-plane representations, exact mathematical solutions are obtained for a number of cases of interest. A method is developed for testing the physical significance of the mathematically derived steady-state solutions. Finally, the techniques developed are applied to the comparative examination of several methods for suppressing "hunting" of the servo. The analysis indicates an anticipatory signal to be the most promising for control of torque application in a high performance relay servomechanism. *Journal of the Aeronautical Sciences*, July, 1946, pages 364–376, 21 illus.

Rotary-Pump Theory. W. E. Wilson. A theory describing the performance of rotary positive-displacement pumps and fluid motors in terms of torque and delivery is presented. From the equations for these two quantities, expressions for power input and power output are developed. The concept of torque efficiency as a complement to the concept of volumetric efficiency is introduced. Equations are developed for the volumetric, torque, and overall efficiencies. Three operating ranges are identified by outstanding characteristics of the performance in each case. Performance charts in dimensionless form are presented and analyzed. Tests on a conventional gear pump operated as a fluid motor yield data that substantiate the theory in one operating range. Additional tests on a cam-type pump give data confirming the predictions of the theory concerning the performance when pumping oils of high viscosity. Alterations of the physical dimensions of the unit are discussed in terms of effect on the performance characteristics. The possibility of the design of units with optimum dimensions is indicated. *Transactions of the A.S.M.E.*, May, 1946, pages 371–384, 12 illus.

Hydraulic Tubing Design. Bernard J. McCabe. An investigation was made of the ways of laying out systems of rigid hydraulic tubing in such a manner as to allow for the movement of the actuating cylinders and avoid stress on the tubing that might cause failure. Formulas are derived for computing the maximum bending stress of various materials from which tubing is made, and figures are provided for substitution in the formulas, with particular reference to three tubing materials designated as "Everdur" tubing, 52 SO aluminum-alloy tubing, and stainless-steel type 302 1/4-hard tubing. The formulas and figures make it possible to determine the permissible deflection without exceeding the fatigue limits of the materials.

The writer considers the installation of hydraulic lines for service, suggesting that three points be especially observed. These are that the line must be devoid of noticeable scratches, dents, or marks; stress concentration at the clamps must be prevented; and the line must be correctly routed to the cylinder fitting. The similarity of the design of hydraulic lines to spring practice is noted, and the same laws that govern the forces applied to coil springs are found to govern coils of tubing. Various types of coiled-tubing installations are described, with the applicable formulas and figures for substitution with respect to the three materials investigated, and for pressures of 1,500 and 3,000 lbs. per sq.in. Other figures are given in tables to show the permissible deflection of the tubing under stipulated conditions. *Aero Digest*, June, 1946, pages 95, 96, 98, 109, 110, 7 illus.

Pardon Me, But You're About to Stall. William D. Strohmeier. A survey of the history of stall-warning indicators begins with the first of such devices, patented in 1912. An extensive description is given of the operation and design of the Safe Flight Indicator. A switch mounted

INDEX

Accessories and Equipment.... 39
Aerodynamics..... 40
Air Transport..... 41
Airplane Descriptions..... 41
Airports and Airfields..... 44
Armament..... 44
Bearings..... 44
Business and Finance..... 45
Civil Aviation..... 45
Control Equipment..... 45
Deicing..... 45
Design..... 45
Electrical Systems..... 47
Electronics..... 47
Engines, Gas Turbine..... 47
Engines, General..... 48
Engines, Reciprocating..... 48
Engines, Rocket..... 48
Flight Testing..... 49
Hydraulics..... 49
Instruments..... 51
Landing Gear..... 51
Lubrication..... 51
Maintenance..... 51
Materials..... 51
Medicine..... 51
Metallurgy..... 53
Naval Aviation..... 53
Performance..... 53
Plant Equipment..... 53
Private Flying..... 53
Production..... 53
Propellers..... 55
Radio..... 55
Reconversion..... 57
Rotating Wing Aircraft..... 57
Stress Analysis..... 57
Superchargers..... 58
Testing..... 58
Testing Equipment..... 58
Welding..... 59

within the leading edge is actuated by a small vane protruding forward from the leading edge about 1/2 in. The location is actually a little below the extreme forward part of the leading edge. When the critical speed and angle of attack are reached for any condition of power or flap setting, the flow direction becomes upward with respect to the vane setting. When this happens, the vane is lifted from its stop and the warning signal is actuated. The writer considers this device the final answer to stall warning. *Air Facts*, July, 1946, pages 27–32.

Movable Landing Light. John F. DuFrane as told to Warren P. Lutey. An account of the design and functions of a movable search and landing light, mounted in the center of the helicopter's nose, is given by the inventor. A brief description of the first flight test with this light, made at Chanute Field, Ill., explains the operational procedure used. The light is easily adjusted to any angle. The wiring technique is described in detail. *American Helicopter*, June, 1946, pages 14, 15, 28, 5 illus.

Aerodynamics

Recent Aerodynamic Developments. Ernest F. Relf. The thirty-fourth Wilbur Wright Memorial Lecture given before The Royal Aeronautical Society on May 30, deals with the latest aerodynamic problems and the results of research carried out in modern wind tunnels. Several lines of recent thought and experiment in aerodynamics which seem to offer great possibilities for the future are discussed. The writer explains the principles of these developments and shows how they are likely to react on the progress of aviation. Consideration first is given to the laminar-flow wing and the story of its development. The nature of the aerodynamic properties of a typical laminar-flow airfoil are examined and the advantages of this type are outlined.

The writer then describes some of the conditions that have prevented the laminar-flow wing from being used more extensively and discusses means of overcoming them. The subject of boundary-layer control by suction next is taken up, with particular attention to the new idea of designing the shape of the airfoil to provide the suction desired. Some of the problems connected with the designing of airfoils incorporating the new principle are outlined, and particulars are given about past and proposed experiments in this field of design. It is stated that steps are already being taken to try a suction wing in actual flight. An examination is made of aerodynamic phenomena that are concerned with the effects of compressibility of the air when speeds become comparable to that of sound. Consideration is given to the theory of supersonic flow around an airfoil and to studies of the behavior of airfoils and complete models in wind tunnels. Comments also are made about aircraft propulsion in the light of recent advances in power-plant design. *The Journal of The Royal Aeronautical Society*, June, 1946, pages 421–449, 17 illus.; "Modern Aerodynamic Developments," Part I, *The Aeroplane*, May 31, 1946, pages 645–648, 6 illus.; Part II, June 7, 1946, pages 674–679, 11 illus.; "Recent Aerodynamic Developments," by E. F. Relf, *Flight*, June 6, 1946, pages 576–579, 8 illus.

On the Velocity Distribution of Turbulent Flow in Pipes and Channels of Constant Cross Section. Chi-Teh Wang. This paper follows the Prandtl conception of momentum transport and gives a critical examination of the so-called Prandtl-Nikuradse formula and the von Kármán formula for the velocity distribution of the turbulent flow in tubes or channels at large Reynolds Number. It shows that both formulas would not give a good picture of the turbulent flow near the center of the conduit. A new formula for the velocity distribution is developed from a study of the mixing-length distribution across the section. This formula checks satisfactorily with the experiments and yields the same skin-friction formula as derived by von Kármán and Prandtl, which

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itself is in good agreement with experiments. *Journal of Applied Mechanics*, June, 1946, pages A-85–A-90, 5 illus.

Approximate Calculation of the Range of a Winged Jet Projectile. M. Zbigniew Krzywoblocki. The possibility of launching winged jet bombs or mail-rockets on extremely long flights is examined. The problem is considered from one standpoint only, that of mass ratio, and is treated in simplified form from the viewpoint of mass ratio at the beginning and at the end of flight. The simplified equations of three points of flight are given—climbing, horizontal flight, and gliding. It is stated that the simplifications introduced present only a rough approximation to the actual problem, but exact solution is not possible because of mathematical difficulties. A short example at the end of the article shows the method of calculating the mass ratio for a flight of 2,000 or 3,000 miles. *Journal of Applied Physics*, June, 1946, pages 515–519.

Airfoil Development and Structure Within the Cambered Surface. Part VIII. Roy A. Liming. In the eighth section of a serial article, the writer calculates the retracted and extended positions and dimensions of the landing gear and the axis of rotation. The procedure involves, first, the establishment of the extended position of the wheel in the side view, defined by such considerations as the center of gravity, desired ground angle, propeller clearance, length of shock strut, and others. The stowed position is next determined by selecting the location of the retracted position with relation to the adjoining structure and the contour of the airplane. Having established the coordinates of the center of the wheel in both the retracted and extended positions, and a convenient second point in the rotating system, the axis of rotation can be determined precisely in a period of 10 min. by means of a calculating machine and analytic calculation charts mentioned in an earlier installment.

Equations are applied to actual design problems by means of examples, one of which is the successful stowing of the main wheel of a tricycle gear within the cambered surface of a thin-profile, high-speed, laminar-flow wing. The solution of that case is given in three steps, and a second case represents the kinematics patterns for the main wheel of the tricycle gear of a four-place private airplane. Variations of the basic equations can be expressed in different terms to meet the requirements of specific problems.

The analytic solution is stated to supersede graphical methods throughout the preliminary and final stages of development. Tables for use with the calculating machine are reproduced, showing the mathematical terms of the equations and certain numerical equivalents. *Aero Digest*, June, 1946, pages 76–79, 106, 3 illus.

Measurements of Friction in a Pipe for Subsonic and Supersonic Flow of Air. J. H. Keenan and E. P. Neumann. The apparent friction coefficient was determined experimentally for the flow of air through smooth pipes at subsonic and supersonic velocities. Values of the Mach Number ranged from 0.27 to 3.87, and of Reynolds Number from 1×10^5 to 8.7×10^5. In supersonic flow the results were found to be strongly influenced by the presence of oblique shocks formed at the junction of nozzle and pipe. The effect of these shocks on the coefficient of friction was determined. Nozzle forms were devised which eliminated the shocks and their effects. It was found that at distances from the pipe inlet greater than 50 diameters the apparent coefficient of friction for compressible flow at Mach Numbers greater or less than 1 is approximately equal, for equal Reynolds Numbers, to the coefficient of friction for incompressible flow with completely developed boundary layer. Mach Numbers greater than 1 are rarely maintained for lengths greater than 50 diameters. For attainable lengths, the coefficient of friction is a function of the ratio of length to diameter and the Reynolds Number, with the Mach Number at entrance determining the maximum attainable length. *Journal of Applied Mechanics*, June, 1946, pages A-91–A-100, 15 illus.

Note on the Characteristics of Low Drag Airfoils. Shao Wen Yuan. A general description of low-drag airfoils is presented. A comparison of the aerodynamic properties of these airfoils with the properties of those of conventional design discloses the advantages and disadvantages of low-drag types. *C.I.E. Journal*, May, 1946, pages 46–48, 2 illus.

Air Transport

Cargoplane to the Fore. An alphabetically arranged table of United States nonscheduled contract air carriers and intrastate air lines includes the following information: name, address, chief executive officer, area of operations, number and type of aircraft in operation, number and type of aircraft on order or being modified, and the kind of pay load carried. The table is prefaced by a general discussion dealing with the advent and progress of air freight. *Air Transportation*, May, 1946, pages 29–32.

Method of Accident Investigation and Prevention Adopted by Air Transport Auxiliary. P. A. Wills. Part I of a three-part article describes the machinery of aircraft accident investigation built up in the British Air Transport Auxiliary. Details are supplied about the purpose of the investigation and the composition of the Accidents Committee. Part II contains data on the rates of accidents and a discussion of the conclusions drawn from them. The third part of the paper describes different accident problems that arose during the course of operations and the remedial steps taken, in accordance with the principles outlined in Part I. *The Journal of The Royal Aeronautical Society*, June, 1946, pages 450–479, 21 illus.

Is Size the Criterion for Airliners? E. Colston Shepherd. The relative merits of the Avro Tudor I and the Lockheed Constellation are compared in a general review of important factors in air-transport qualifications. The necessity for long range is felt to be more important than increased pay load. High utilization is another reason cited for the smaller pay-load capacity of the Tudor I. *Wings* (*South Africa*), March, 1946, pages 13, 14, 2 illus.

Airplane Descriptions

The Husky Makes Its Debut. The F-11 Husky, a new all-metal, single-engined airplane built by Fairchild Aircraft Limited, Quebec, to meet Canadian requirements, is described. It is intended primarily as a cargo carrier and every effort has been made to provide adequate cabin facilities for the easy handling of freight. The provision of many interchangeable components reduces both manufacturing and maintenance costs. The Husky can be operated on wheels, skis, or floats, and is readily convertible from one to the other. Important specifications and performance estimates are listed. *Aircraft and Airport*, May, 1946, pages 43, 44, 46, 1 illus.

Heavily Gunned XA-41 Was Groomed as a Ground Strafer. A brief description of the Convair XA-41, single-seat attack plane, which was developed during the latter stages of the late war but never reached the production line. Specifications are listed and information is supplied about its armament. It is reported to have a top speed of 363 m.p.h. and a combat range of 800 miles. *Aviation*, June, 1946, page 95, 2 illus.

British Transport Aircraft. A list of British transport aircraft in production or expected to be in production before the end of 1947 is published in tabular form. Derived from the Official Report of the Ministry of Supply, the information includes the name of the maker; number and type of engines; range, accommodations, and other descriptive data; gross weight; and cruising performance. *The Aeroplane*, May 24, 1946, page 618.

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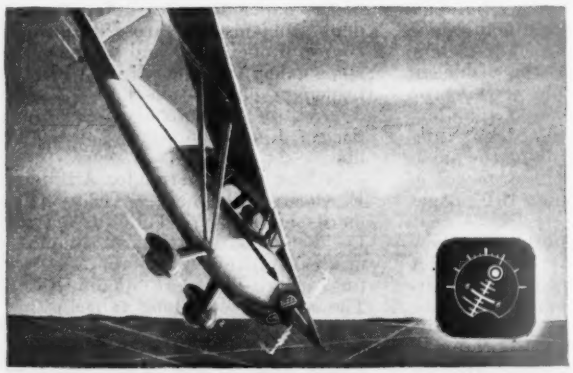

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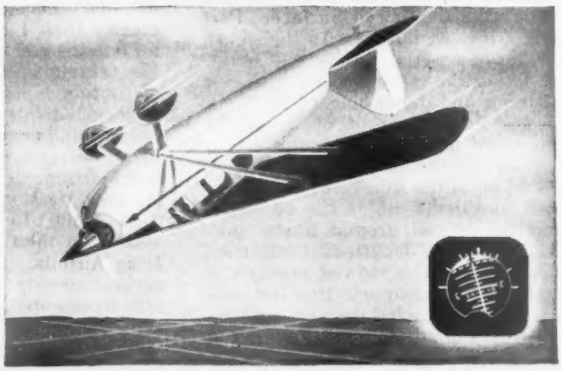

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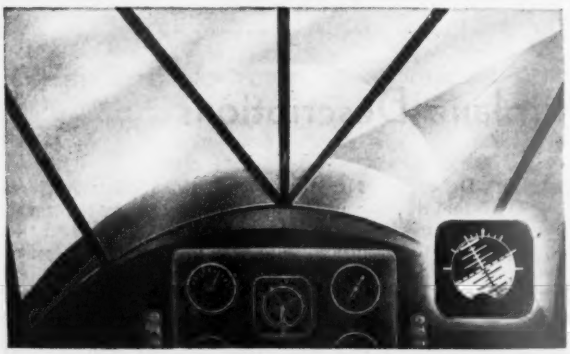

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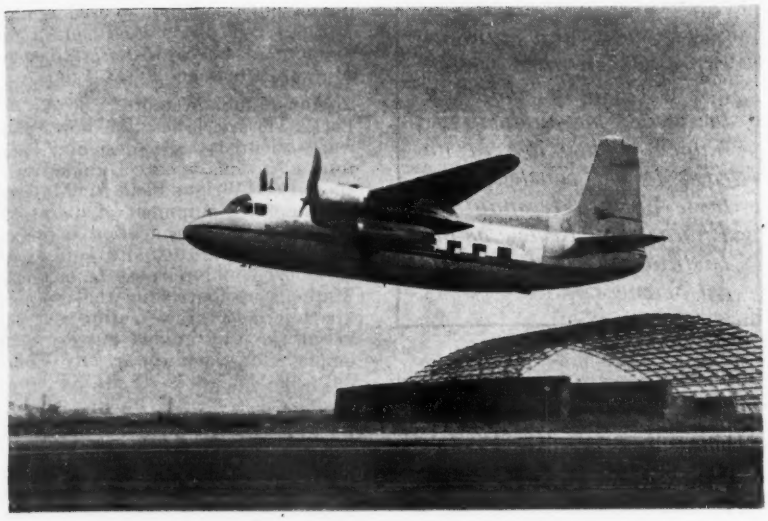

The Lockheed Saturn transport. (See page 81.)

These Jets. An illustrated list contains brief details of jet-propelled aircraft that have flown up to the present time. Included in this list are U.S. Army and Navy jet-propelled aircraft, and those built in Great Britain, Germany, Italy, and Japan. *Aircraft and Jets*, June, 1946, pages 5–14, 33 illus.

High-Speed Research. A brief, illustrated article on the de Havilland 108 states that the aircraft has been designed and built solely for the purpose of exploring control and stability problems in aircraft with swept-back wings. Although it resembles a "flying wing," it is not of that type but has the fuselage of the standard Vampire. The wing, with its slots and "elevons," embodies design features that may eventually be reproduced in the de Havilland 106 or the Brabazon IV transport. The pronounced sweepback of the wing is intended to delay the onset of compressibility effects. It is hoped that data may be obtained for later application to both military and civil aircraft. *Flight*, June 6, 1946, pages 561, 562, 2 illus.

Bellanca Cruisair, Sr. Leighton Collins. A detailed description is given of the physical characteristics of the Bellanca Cruisair Senior, a four-seat private plane, powered by a 150-hp. six-cylinder Franklin engine. Comments are made about the control system, and the take-off, landing, and flight characteristics. *Air Facts*, July, 1946, pages 66–76, 4 illus.

V Parade in the Air. Brief specifications and silhouettes outline the essential details of a group of British military aircraft. Among the types reviewed are the Hurricane IV; Short Sunderland V; Handley Page Halifax C. VIII; Avro Lancaster III and VII; de Havilland Mosquito XXX, XXXIII, XXXVI; Bristol Beaufighter; Blackburn Firebrand IV; Fairey Firefly I; Supermarine Seafire XVII; Spitfire XIV, XVI, IX, and XXI; de Havilland Hornet; Hawker Tempest II and V; Gloster Meteor III; and de Havilland Vampire I. In addition to the specifications, short comments are made concerning the service record of each type. *Flight*, June 6, 1946, pages 570a, 570b, 17 illus.; "Victory Fly-Past," *The Aeroplane*, June 7, 1946, pages 662, 663, 18 illus.

More About the Tudor II. Additional details are supplied about the Tudor II, officially known as the Avro XXI Type 689. This low-wing, all-metal monoplane is powered by four civilian-type Rolls-Royce, Merlin 621 power plants rated at 1,740 hp. for take-off, which give a cruising speed of up to 250 m.p.h. with a maximum range of 2,950 miles, carrying 7,150 lbs. of passengers or freight. The most important operational use of the air liner in the immediate future is expected to be on Empire air routes of up to 2,000 miles. The fuselage constitutes the main difference between the Tudor I and the Tudor II. In the Tudor II the circular fuselage is constructed in five sections; the nose piece, the front center section, the center section, the rear center section and the rear fuselage.

The pressurization system of the double-shell fuselage, stressed up to an air pressure differential of 11½ lbs. per sq.in., is described extensively. A differential pressure of 5.5 lbs. per sq.in. is achieved; while flying at 25,000 ft. the cabin "altitude" is held at 8,000 ft. A single HC Mk. 11A pump, driven from the starboard inner engine, provides the power for the hydraulic system from a supply on the outboard-engine rib of the starboard inboard nacelle. Both this system and the pneumatic system are explained. The fuel and oil systems are briefly outlined, as well as the construction of the center section and mainplane assemblies.

The accessories and equipment are detailed under the following headings: hydraulically operated wing flaps; mainplane mooring shackles; electrical system and radio equipment. The landing gear comprises two main-wheel units using a Dowty oleo A916Y, with Dunlop wheels and brakes. The deicing equipment and the cabin interior are described. Two pages are devoted to a schematic drawing of the transport. *The Aeroplane*, June 7, 1946, pages 666–673, 15 illus.

Civil Aircraft in France. A general survey of civil aircraft production and design in France, which includes a few of the light planes shown at the Toussus le Noble Easter exhibition in France. Among the aircraft mentioned are: the 22-ton Languedoc 161 transport, which carries 33 passengers and 2,400 lbs. of freight; the jet-propelled SO-6000, powered by a German Jumo 004 engine and expected to fly at 530 m.p.h.; the SO-30R, with 1,700-hp. Gnome et Rhone 14R engines, carrying 30 passengers at a cruising speed of 275 m.p.h.; SO-94 mailplane, fitted with two 600-hp. Renault 12.S engines; and the SUC-10, a pusher-type four-seater, powered by a 200-hp. Mathis G-8R engine. *Flight*, May 23, 1946, pages 527–529, 11 illus.

Transport Aircraft Survey. Thirty-three Canadian, British, and American transport aircraft are briefly described and illustrated. Condensed specifications included are cruising speed, range, passengers, pay load, and gross weight. Other specifications in table form provide the following information: maker, power plant, propeller, performance, seating, dimensions, and weights. *Canadian Aviation*, June, 1946, pages 52–74, 35 illus.

Hermes/Hastings Prototype. In this account a tabulated record is reproduced of the flight tests of the second prototype of the Handley Page transport, the Hermes/Hastings. Predicted specifications for the proposed Hermes Mk. II are included. A cruising speed of 300 m.p.h. and a top speed of 355 m.p.h. are both in excess of estimated figures. The high speed is attributable not only to aerodynamic planning and careful finish but to the design of such items as fillets, and the modern engine installation, free of parasitic protuberances. The four engines are underslung, leaving an almost unimpeded upper wing surface. *Flight*, June 6, 1946, pages 566, 567, 4 illus.

"Junior Peashooter." Jay Gude. The 1946 version of the Knight Twister biplane, designed for high-performance acrobatics, is briefly described and illustrated. This small craft is reported to be able to climb at 1,400 ft. per min., to have maximum indicated speed of 155 m.p.h. and range of 510 miles on 18 gal. of fuel, when powered by a 75-hp. engine. *Skyways*, July, 1946, pages 35, 66, 3 illus.

The Miles Marathon—Brabazon Type 5a. An all-metal, high-wing monoplane, the Miles Marathon Brabazon Type 5a, is fitted with four de Havilland Gipsy Queen 71 engines, a retractable, tricycle landing gear, and twin rudders. The engines are below and ahead of the wing, giving an unimpeded upper surface along the whole span of the wing, which is considered not only an aerodynamic advantage but also simplifies accessibility and engine removal. The aircraft is so designed that gas-turbine power units can be installed.

The arrangement of the cockpit and the instrument layout are described. Latest types of radio communication and navigational aids have been incorporated in the airplane. The propellers are of the full-feathering type with a reversible pitch control. The retractable tricycle landing gear is of simple and sturdy design with generous bearing surfaces, and is operated pneumatically. The nosewheel arrangement not only requires the minimum skill on the part of the pilot in landing and take-off but also allows him an adequate field of vision when on the ground. Operational cost estimates and specifications are set forth in table form as well as in the text. *The Aeroplane*, May 31, 1946, pages 630–633, 7 illus.; "Miles Marathon," *Flight*, May 30, 1946, pages 545, 546, 4 illus.

Meyers Grooming Fast New Two-Placer. A brief item gives particulars about the Meyers MAC 125-C, a side-by-side two seater made by the Meyers Aircraft Corporation, Tecumseh, Mich. Wing slots and a retractable landing gear are used on this low-wing personal airplane, which is reported to have a top speed of 140 m.p.h. It is powered by a 125-hp. Continental engine. *Aviation*, June, 1946, page 92, 2 illus.

The Short Amphibian. The aim of the designers of the Short amphibian twin-engined flying boat was to produce a small amphibian of outstanding utility and performance, incorporating established principles with simplicity of design and ease of maintenance, yet capable of large-scale production. Powered by two de Havilland Gipsy Queen 71 engines of 331 hp. maximum output each, the Short amphibian will have a maximum cruising speed of 168 knots. With a normal weight of 8,500 lbs., five passengers and baggage totaling a weight of 1,000 lbs. can be carried for a range of 540 nautical miles. Constant-speed, full-feathering and braking propellers will be fitted. Specifications available at this time are provided. *The Aeroplane*, June 7, 1946, page 665, 1 illus; "British Amphibian," *Flight*, June 6, 1946, page 565, 1 illus.

Lightplanes: Europe. A. E. Hotchner. Developments in private flying and private-plane manufacture in European countries are reported. Brief descriptions of some Continental light planes are presented.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Particulars are supplied about the Swiss Pilatus P-2; the Swedish SAAB-91; the Czechoslovakian Praga E117 and E210; the KZ-111 airplane produced in Denmark and popularly called the Lark; and a new Russian light plane named the Courier, reported to have been designed by Yakovleff. Comments are made about the situation in Italy, Turkey, and other countries, and about two light planes that were produced in Germany. *Flying Age*, July, 1946, pages 12–14, 44, 45, 3 illus.

Airports and Airfields

Seaplane Base Development. Part II. Howard P. Beach, Jr. The second installment of a serial article on considerations in the development of a seaplane base outlines the procedure to follow in establishing a seaplane "restricted area." Factors involved in the selection of a site for the anchorage and base facilities are discussed. Information is supplied about the construction of floating docks and seaplane ramps. *Aviation Maintenance & Operations*, June, 1946, pages 30, 31, 94, 96, 8 illus.

Turf Maintenance Increases Safety. J. R. Yarrow. Methods of turf maintenance followed at Carlstrom Field, Arcadia, Fla., an airfield with an outstanding safety record, are described. The history of the development of the airfield is outlined and details are supplied about the various maintenance operations. *Aviation Maintenance & Operations*, June, 1946, pages 37, 80, 82, 84, 86, 88, 90, 1 illus.

Armament

Construction and Performance of the Baka. Wallace J. Osborn, Jr. An account of the Japanese jet-driven suicide bombs gives details about their construction and performance characteristics. The writer describes the construction of the war head, wings, tail unit, and rocket installations of the Baka. It is stated that the maximum gliding speed in level flight is 230 m.p.h. and the maximum horizontal range when released at 27,000 ft. is 55 miles. A ground-launched, piloted "suicide" rocket bomb that the Japanese used against B-29 aircraft also is described. *Journal of the American Rocket Society*, March, 1946, pages 20–23, 1 illus.

Man-Made Meteors. J. L. H. Peck. The article describes how American scientists are designing and testing various types of guided missiles at the Wright Field Air Matériel Command Equipment Laboratory. A method of classification in which the weapons are listed according to their type and purpose is outlined. Methods of controlling the weapons are described. Information is given about the way guided missiles were employed in the late war. *Air Force*, July, 1946, pages 15–18, 64, 8 illus.

Bearings

Important Engineering Data on Aluminum Alloy Bearings for Engines. D. B. Wood. Particulars are given about three aluminum alloys developed by the Aluminum Company of America for use in connecting-rod, main, and thrust bearings. Designated as 750-T533, XA750-T7, and XA80S, it is stated that these alloys are the result of exhaustive research and laboratory and field tests. Although they have so far found greatest usage in the Diesel engine field, it is expected that they will be used in other fields.

The history of aluminum-alloy bearing developments is outlined, and particulars are supplied about the properties of the new alloys and their performance as revealed by tests. Both all-aluminum-alloy bearings and the steel-backed type are discussed. The typical mechanical and physical properties of aluminum bearing alloys are listed in tabular form. *Automotive and Aviation Industries*, June 1, 1946, pages 26–30, 74, 76, 78, 4 illus.

Bearing Failures—Causes and Cures. Part II. R. W. Dayton and R. E. Adams. Information about the causes of bearing failures and methods of overcoming them is supplied in the conclusion of a two-part article. Consideration is given to partial lubrication, which defines a wide range of types of lubrication, from adsorbed films of molecular dimensions to much thicker films of nearly the thickness obtained with hydrodynamic lubrication. It is explained that conditions are much more severe with thin films, and the speeds and loads must, therefore, be kept lower. The design should be such as to provide the greatest possible thickness of the lubricant film. Galling, which is the most important cause of bearing failure, and its prevention, are discussed. Other sections deal with the design of oil grooves in aircraft-engine bearings, difficulties with the type of bearing surface in which the motion is reciprocating, the effects of small movement on ball bearings, and the prevention of surface contact. *Machine Design*, June, 1946, pages 128–132, 5 illus.

Business and Finance

Financial Statistics of Air Lines. Tabulations contain figures based on the annual reports of 16 domestic air lines for the 12 months ended December 31, 1945. One table shows the balance-sheet items, giving current assets, total assets, current liabilities and total liabilities, capital stock, and surplus accounts of each company. Another table contains a comparative statement of income and expenses, showing the sources of income, operating expenses divided into aircraft and ground categories, net operating income, net income before taxes, provision for taxes, and net profit for the year. A similar table analyzes the income and expenses per plane-mile.

A fourth table reports the number of miles flown, passengers carried, passenger-miles and ton-miles, flight capacity, and average daily aircraft utilization. *Air Transport*, June, 1946, pages 90, 91.

Civil Aviation

Is the Air Full? Wolfgang Langewiesche. The air-traffic control system used at present by the commercial air lines is explained by a description of a typical flight in inclement weather. Although the present system is safe, it is stated to be inconvenient in bad weather. A suggested solution to the problem is to elaborate on the present system. This can be done, but the system will eventually reach a saturation point due primarily to human error. An attempt is being made to mechanize the controller's thinking, the pilot's reporting, and the transmission of communications by means of an electric control board. The feasibility of using radar is discussed and an analysis of two promising devices, "Teleran" and "Navar," is presented. *Harper's Magazine*, July, 1946, pages 10–20.

Clarification of the Federal Airport Act. J. Kirk Baldwin. In this analysis of the Federal Airport Act the writer explains its provisions and states what it will mean to civil aviation. He also explains what action airport sponsors must now take. *Airports*, June, 1946, pages 37–40, 5 illus.

Control Equipment

Case for the Full-Pneumatic System. Part II. James L. Dooley. The conclusion of a two-part article discusses the use of compressed air for the overall actuation of aircraft auxiliary systems. An analysis is made of system weight factors. Service and experimental air usages are outlined. Details are given about typical air systems for large twin-engined and light single-engined aircraft. *Aviation*, June, 1946, pages 76–80, 14 illus.

Deicing

Development and Application of Heated Wings. Capt. Myron Tribus. Design problems in heated-surface anti-icing equipment are analyzed. A compilation is presented of heat transfer data known to be available and considered to be required for current and future design. The report supplies a rapid means of calculating heated-wing requirements, charts of heat transfer coefficients, a discussion of instrumentation techniques, and a method of calculating surface temperatures in dry air. *SAE Journal*, June, 1946, pages 261–269, 309 (Transactions), 23 illus.

Design

The High-Wing Pusher. Richard G. Naugle. The design difficulties and operational restrictions of the twin-engined, low-wing, tricycle-geared plane are discussed. Inasmuch as all of these difficulties are directly attributable to the location of the wing and the mounting of the engine on the wing, the writer investigates certain aspects of the reversed arrangement of a high-wing type with the engines mounted in the pusher position, in the hope of eliminating, at the start, these operational restrictions. It is suggested that the pusher arrangement is aerodynamically superior in practically every way to the tractor in regard to the effect of the propeller on the wing itself.

The writer concludes that the overall efficiency of the wing for a pusher is greater than that for the tractor for the following reasons: (1) it results in considerably less drag and allows the use of low-drag airfoils without loss of effectiveness; (2) allows a slightly greater propulsive efficiency; and (3) while developing a somewhat lower maximum lift coefficient with power on, allows a larger maximum lift coefficient with power off, since the leading edge of the wing is not distorted by nacelles. A point of considerable importance with regard to the low-wing tractor and the high-wing pusher is their comparable longitudinal stability and control characteristics near the stall with power on. The components involved in this factor are evaluated. The various methods for cooling the engines are reviewed, and the other great difficulty, the installation problem of the landing gear, is considered. *Western Flying*, June, 1946, pages 24, 25, 40, 42, 7 illus.

De Havilland Hornet. Part II. Wilfred E. Goff. Further details about the construction of the de Havilland Hornet, a two-engined cantilever monoplane of wood and metal construction, are presented in the second illustrated installment of a design analysis. Particulars are supplied about the mainplane assembly and the building of the fuselage. The Hornet fuselage is another example of the de Havilland balsa-plywood sandwich construction used first in the Albatross and then in the Mosquito. Advantages of the concrete molds used as a substitute for wood for the manufacture of the half-shells are described. The use of electric heating and the application of pressure in this process is explained. Tools and methods used in assembling the parts are reviewed. *Aircraft Production*, June, 1946, pages 281–290, 26 illus.

Visual Factors in the Design of Military Aircraft. Major E. A. Pinson and Capt. A. Chapanis. It is noted that the experience gained in the recent war has shown that standards of vision range from military aircraft must be high for maximum operational efficiency. The writers discuss studies undertaken by the Army Air Forces to provide a set of recommendations to aircraft designers regarding the ways in which these standards of high vision may be maintained. Two groups of studies on the fields of view from fighter aircraft and the optical quality of transparent panels are summarized. *Journal of Aviation Medicine*, April, 1946, pages 115–122, 5 illus.

Airplane Heating and Ventilating Involves Many Special Problems. Maurice Martin. Engineering problems connected with the heating and ventilating of transport aircraft are investigated. Emphasis is placed on the importance of proper heating and ventilating for passenger comfort and safety. Physiological considerations are outlined. Attention is given to the determination of the requirements for heating and ventilating, including the quantity of air supply, the heat-transmission coefficient, and heat balance. *Heating, Piping & Air Conditioning*, June, 1946, pages 89–93, 3 illus.

The Flying Boat Has a Future. Capt. Frank T. Courtney. In this analysis the writer endeavors to show that the flying boat is not commercially obsolete but that it has a future. Detailed consideration of various phases of the subject leads to the conclusion that the landplane is today a more satisfactory airplane for airline operators, not because it is a landplane, but because it is used in connection with elaborate and expensive surface facilities. It is predicted that before long it will be realized that aircraft operating from water surfaces can be used with more efficiency and at less cost. *Air Trails*, July, 1946, pages 24–27, 113–116, 8 illus.

Simplifying Personal Plane Design. Part I. Ralph H. Upson. Part I of a series on the design of per-

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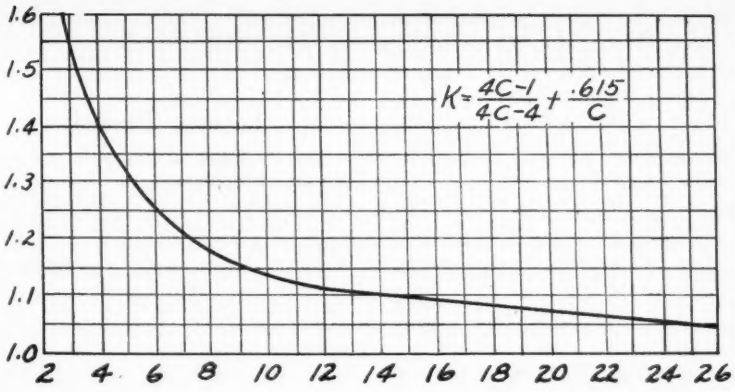
sonal airplanes, in which problems of proportioning and degree are considered and formulas are given to aid in the work of designing airplanes. Troubles experienced by the engineering department in the designing of a new plane are outlined, and the advantages of an empiric approach to the problem are pointed out. Examples are given of the way engineering research results can be put into practical form. *Aviation*, June, 1946, pages 55–59.

Wings to Come. R. G. Worcester. A former British naval pilot speculates on forthcoming trends in combat-aircraft design. Brief discussions of an interceptor, assault fighter, light bomber, heavy bomber, and a patrol flying boat include design details, specification needs, probable future design, and suggested armament. *Air Reserve Gazette*, June, 1946, pages 24, 25, 4 illus.

Handley Page's New Transport. Descriptive details and performance data are provided about the Handley Page Hermes 68. The transport is an all-metal, low-wing monoplane, powered by four Bristol Hercules 101 engines of 1,675 hp. each, fitted with de Havilland four-bladed, constant-speed, full-feathering and reversible-pitch propellers. The cabin is pressurized and can accommodate up to 50 passengers (or an equivalent amount of freight) with a crew of five or seven. The landing gear is fully retractable, by means of electro-hydraulic mechanisms. The maximum normal range is about 3,000 miles. It is stated that the Hercules is an air-cooled engine giving some 500 hours between overhauls. The various components of the aircraft which are described in detail are fuselage construction; engines; landing gear; fuel-tank system; wing assembly; tail-plane structure; controls and control surfaces; hydraulic, pneumatic, and electrical equipment; wiring; and the power units. A 2-page annotated cutaway drawing together with photographs and sketches show the construction details. Charts record the performance characteristics. The principal specifications are tabulated. *The Aeroplane*, May 24, 1946, pages 606–613, 14 illus.

Electrical Systems

Warming Aircraft Accumulators in Sub-Zero Temperatures. Flight Lt. P. R. Woodfield. Because low temperature reduces the amount of current that can be drawn from the battery of an aircraft-engine starting system, tests were conducted to determine whether a standard battery could be made self-warming by installing an electric heater between the battery and a metal case in which it was mounted. Cooling curves were obtained with and without the metal case. The apparatus used for the tests is described and the results of the investigation are summarized. It is concluded that the heating of the battery by power drawn from it appears practical provided an upper limit of 15 watts drain is maintained. *Aircraft Engineering*, May, 1946, pages 160–162, 4 illus.



Stress correction factor for helical coils. The correction factor K is plotted along the ordinate and the K-D/d spring index plotted along the abscissa. (See "Hydraulic Tubing Design," page 39.)

Alternating Current Power for Large Aircraft. T. B. Holliday. The writer analyzes the complex engineering considerations that resulted in the adoption of 400-cycle a.c. power for large aircraft. He explains the relative advantages of a.c. and d.c. power and discusses methods of distribution, voltage and frequency combinations, and constant-speed differential couplings. *Product Engineering*, June, 1946, pages 503–508, 10 illus.

Unit System of Ignition Aims at Better Performance. Brief information is supplied about a new aircraft-engine ignition system designed to provide easier starting in sub-zero weather, overcome spark-plug fouling, and eliminate corona effects. This unit system of ignition is produced by the AC Spark Plug Division of General Motors Corporation. *Aviation*, June, 1946, page 74, 5 illus.

Electronics

Television Equipment for Guided Missiles. Charles J. Marshall and Leonhard Katz. A summary is given of the technical problems associated with the development of compact airborne television equipment. The system provides resolution, linearity, and stability which approaches that obtained from broadcast equipment. Technical difficulties that arose after the completion of the equipment design are described. The final solution of these and other problems resulting from its installation in guided missiles is discussed. Photographs taken from the receiver screen during experimental flights are shown.

It is stated that airplane-to-airplane transmissions of television pictures are feasible. Many difficulties still may be encountered but, in general, successful transmission may be accomplished if the following precautions are observed: (1) Transmitting equipment must be protected from interference produced by acoustical noises encountered in aircraft. Receiving equipment must be protected from interference produced by electrical noises encountered in aircraft. (2) A stable master oscillator must be used in the transmitter, preferably followed by a buffer stage, in order to keep the frequency deviation due to frequency modulation less than the picture-line frequency. (3) The ratio of direct-to-reflected signal strength in the receiving airplane must be kept as high as possible. Compact, lightweight television equipment can be used in guided missiles, and clear pictures, free from all interference, can be obtained if the aforementioned points are heeded. (4) The contrast of the viewed scene must be high and possible targets should be located close to prominent landmarks so that they can be located easily. *Proceedings of the I.R.E. and Waves and Electrons*, June, 1946, pages 375–401, 71 illus.

Engines, Gas Turbine

Report on British Jet Engines. Albert A. Arnhym. In compliance with a request by the Air Documents Division of A.A.F. Intelligence, the British Ministry of Aircraft Production permitted the writer to visit a number of prominent jet-engine establishments in England. The purpose of these visits was to obtain an overall picture of manufacturing methods and trends in the production of British jet engines and thus to supplement similar data on the German aircraft industry which had been collected by the Air Documents Division of Air Forces Intelligence. The article is limited to a discussion of the economic and manufacturing aspects of British jet-engine production, bringing out some of the highlights of jet-engine manufacture, and indicating the vast amount of research and development that has brought the jet engine to its present state.

The writer comments on the superior development of jet engines in

England but concludes that Britain cannot compete with the American production of commercial air liners or in international air traffic. Activities at the following plants are described: the Rolls-Royce plant at Newcastle-under-Lyme, the two de Havilland jet-engine factories in London, and the Joseph Lucas organization in Lancashire. In referring to the welding system, the writer states that the British do not appear to have any welding technique or corresponding method which could be considered superior to that used in the United States. Checking for surface cracks in welded parts is done mostly by means of the chalk method. Various types of jet engines are listed, accompanied by a brief history of each. *Aero Digest*, June, 1946, pages 22, 23, 151, 152, 1 illus.

Engines, General

The Evolution of Energy in Jet and Rocket Propulsion. P. Bielkowicz. The sixth installment of a serial article on jet and rocket propulsion contains further particulars about the transformations that energy undergoes on the way from the fuel container to the end of the nozzle. It is noted that when the temperature of the gases reaches a high level the molecules begin to break up into atoms or groups of atoms which, after recombination, form new and smaller molecules of a simpler structure. The mechanism of this dissociation is described in detail. *Aircraft Engineering*, May, 1946, pages 163–170, 18 illus.

Engines, Reciprocating

Jameson Aero Engine. The new flat-four, light-aircraft engine developed by Jameson Aero Engines, Ltd., of Ewell, Surrey, England, is claimed to be capable of lower normal specific fuel consumption figures than have ever before been attained. As an engine, the physical design and layout conforms to accepted flat-four practice, but an unconventional detail has been inaugurated on the basis of the Jameson induction theory. The theory is based on the premise that turbulence is a disadvantage and that a progressive stratification in mixture strength is more to be desired. This condition is accomplished by causing the ingoing charge in the induction pipe to vary from weak to rich, with the rich portion of the charge entering the cylinder last. After ignition, while the rich part of the charge is expanding, the remainder will be undergoing its compression cycle and burning at a rate more or les relative to the rise in pressure. Therefore, the engine would be capable of adjusting its own rate of compression to suit the mixture strength as it burned. The application of the Jameson theories is recounted, reviewing the designer's series of experiments. Engine test data accepted by the Air Ministry are listed, and the cylinder assembly is described in detail. The high power and fuel economy of the Jameson unit are said to be comparable to the gas turbine in its characteristic of operating more efficiently and economically at 90 per cent of its power. *Flight*, May 23, 1946, pages 511–514, 9 illus.

Lightplane Diesel. Gilbert C. Close. A Diesel engine designed for light-plane use is described in detail. Claimed to be the first ever developed, two prototypes, identical in design except for their fuel-injection systems, produce 100 and 125 hp., respectively. The engine is of conventional horizontally opposed, air-cooled design and is intended for installation on a two- or three-place light plane, cruising between 90 to 130 m.p.h. Total engine weight, without accessories, is 235 lbs. Other features detailed are the constructional dimensions, the lubrication system, operational characteristics, and the fuel-injection system. *Flying*, July, 1946, pages 42, 98, 1 illus.; "Diesel Power for Personal Planes," by Robert C. Hare, *Air Force*, July, 1946, pages 56–58, 7 illus.

Engines, Rocket

The HWK 109-509 Rocket Unit. Eric Burgess. Features of the German HWK 109-509 bifuel rocket jet

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unit that was used in the Me 163 "Komet" and the BP.20 Natter are analyzed. Troubles experienced with the use of liquid oxygen as an oxidizer, which included difficulty in handling, were overcome by the use of an oxidizer composed of hydrogen peroxide used in conjunction with a mixture of hydrazine hydrate and methanol as the fuel. The problem of supplying large quantities of fuel at high pressure, a major difficulty in rocket-engine design, was met by the use of fuel pumps operated by a turbine motivated by superheated steam produced in a special chamber by the decomposition of hydrogen peroxide, employed as an auxiliary fuel. A third difficulty, that of providing efficient cooling and the prevention of engine burnout, was solved by constructing the engine with a double wall and circulating one of the fuels in the space between the walls prior to injection into the combustion chamber. It is explained that this produces two good results, for not only does the fuel cool the engine but the engine preheats the fuel. The performance of the HWK 109-509 rocket unit is discussed and illustrations show the design of the component parts.

The writer states that there is no doubt that this unit has opened a new period in the development of aircraft power plants, but nevertheless it is unlikely that such units will find extensive application in present-day types of aircraft. For use in interceptor fighters the unit is ideal because the short duration is counterbalanced by an extraordinarily rapid rate of climb and an increase in armament which is made possible by the lightness of the power unit. The opinion is expressed that if flying in the upper reaches of the atmosphere is accomplished in the future, the pure rocket jet unit will be used to provide the motive power. *Aeronautics*, June, 1946, pages 36–39, 4 illus.; "Rocket-Propelled Interceptor Fighters," by E. Burgess, *Journal of the American Rocket Society*, March, 1946, pages 18, 19, 23, 1 illus.

Trends in Rocket Propulsion. Harry Raech, Jr. Developments in rocket propulsion are reviewed. Both solid and liquid types of fuel are discussed and consideration is given to the advantages and disadvantages of each. The various types of liquid-fuel and solid-fuel rockets are described. *Machine Design*, June, 1946, pages 133, 134, 3 illus.

Develop Potent Rocket Engine for Navy's Supersonic Planes. A brief item describes a new liquid-fuel rocket engine designed to power supersonic aircraft. Developed by Reaction Motors, Inc., Pompton Plains, N.J., in conjunction with the Navy Bureau of Aeronautics, it weighs 200 lbs. and is said to be capable of delivering 6,000 lbs. thrust at sea level. Designated as the 1500N4C, the engine basically consists of four cylinders, each capable of delivering 1,500 lbs. thrust. Each cylinder contains an igniter, combustion chamber, and expansion nozzle. The propellants consist of a specially developed alcohol compound for fuel and liquid oxygen as an oxidizer. *Aviation*, June, 1946, page 71, 3 illus.

Rocket Fighters. H. F. King. Present applications and future possibilities of the propulsive rocket for fighters are examined in detail. For a basic description of this form of power plant the writer refers to the German rockets and cites comparisons between various types. The fuel consumption and construction of present rockets are studied, and the existing limitations are enumerated. The problems involved in designing a turbine rocket fighter are discussed in connection with pertinent tests. The writer states that the main problem is the stowage of the fuels and the location of the unit, particularly the propulsion nozzle. Descriptions of a number of German rockets are provided. *Flight*, May 23, 1946, pages 519–523, 8 illus.

Flight Testing

Development of Precision Radio-Controlled Dynamically Similar Flying Models. Ernest G. Stout. Great progress has been made in recent years toward improving the reliability, speed, and accuracy of the various experimental test procedures available to the aircraft designer. This paper describes the development of such a procedure whereby flying scale models, which are dynamically similar scale duplicates of the full-scale prototypes, may be accurately flight-tested through the use of positioning, multichannel radio remote control. This development allows the designer to determine accurately many dynamic characteristics of a new design which would not ordinarily be available until the actual airplane is flight-tested. This procedure is particularly well adapted to the determination of dynamic stability during the take-off and landing of flying boats and was developed primarily for this purpose. However, it is directly applicable to many other dynamic problems of both landplanes and seaplanes.

The design and construction of the self-propelled free flight models and the remote control equipment are considered, as well as a general discussion of the instrumentation, analysis, and testing procedure. It is concluded that:

(1) Full-scale hydrodynamic stability can be accurately predicted by scale, free body, dynamically similar models through the use of multichannel radio remote control.

(2) The special Consolidated Vultee radio transmitter and receivers, designed for the proportional control of seven simultaneous channels, have proved entirely feasible and reliable.

(3) The special two-cylinder, two-cycle gasoline engines have excellent speed control characteristics and have proved satisfactory and dependable under the most severe conditions of salt water and continuous high-power operation.

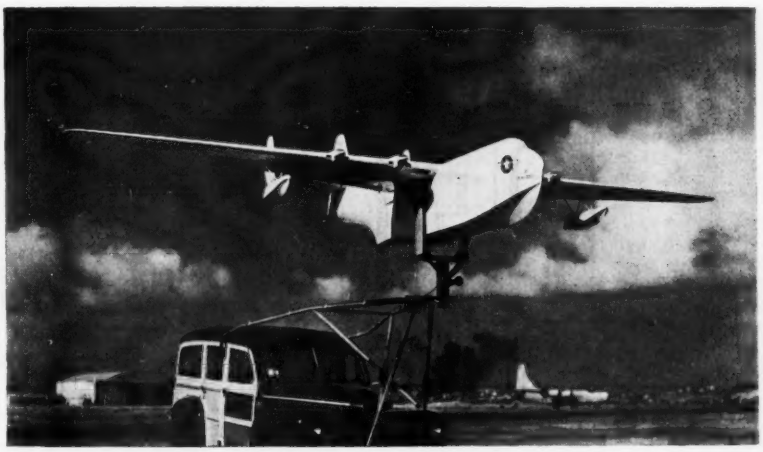
(4) The method of instrumentation and analysis for free bodies has proved to be simple, rapid, accurate, and extremely versatile in its operation.

These conclusions are substantiated by extensive operation and the results of full-scale correlation. *Journal of the Aeronautical Sciences*, July, 1946, pages 335–345, 22 illus.; "Radio-Controlled Free-Flight Models," *Air Trails*, July, 1946, pages 44–47, 13 illus.

Hydraulics

Dimethyl-Silicone-Polymer Fluids and Their Performance Characteristics in Hydraulic Systems. V. G. Fitzsimmons, D. L. Pickett, R. O.

This setup of the Consolidated Vultee scale model and car enables the determination of many flight characteristics without risking flight.



PISTON PINS

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BELL ENGINEERING

KNOXVILLE, TENNESSEE

Militz, and W. A. Zisman. The investigation concerns research on the polymethyl siloxanes or dimethylsilicone polymers, and their uses as lubricants and hydraulic fluids. It is shown that these new fluids give excellent results when operated in a standard aircraft-type Pesco gear pump. It was found that the silicones when used in a gear pump fitted with cast-iron bushings caused serious wear and disintegration of the bushings at pump pressures of only 600 lbs. per sq.in. It is concluded that the loaded surfaces of steel sliding on cast iron or on steel are not adequately lubricated by the silicone fluid, whereas steel sliding on bronze is effectively lubricated. A simple, manually operated slider-and-plate test method was found to be capable of permitting the discrimination between good, bad, and indifferent bearing combinations for use with silicone fluids.

Results with 156 combinations of metals are summarized. A method also is given for relating these observations to the practical problem of selecting suitable metals for use in lubricating the sliding parts of machinery with silicones. The results are related to observations on the choice of suitable metals for gear pumps, piston pumps, and journal bearings. It is shown that the same conclusions relative to steel sliding on steel or on bronze are reached from tests with the Vickers piston pump. *Transactions of the A.S.M.E.*, May, 1946, pages 361–369, 3 illus.

Instruments

Liquid Mass Measurement Ups Fuel Gaging Accuracy. Carl H. Odell. In the Edison Liquid Gaging System mass rather than volume is used as the basis of measurement of the quantity of fuel in aircraft gasoline tanks. The mass is determined by capacitance-change indication. A circuit diagram of the electronic tank gage is shown, together with a cutaway view of the gage installed in an aircraft wing fuel tank and photographs of the electronic transmitter. *Aviation*, June, 1946, pages 72, 73, 5 illus.

Landing Gear

Noteworthy Landing Gear Types. Part I. Various types of landing gear and their advantages and disadvantages are noted in an article describing the products of four personal-plane manufacturers and their particular treatment of landing-gear design. The aircraft listed are the Commonwealth Skyranger, the Cessna Models 120 and 140, the Fairchild F-24, and the Culver Model "V." Photographs of each type are supplied. A future issue of *Aero Digest* will discuss landing-gear details of other light planes. *Aero Digest*, June, 1946, pages 84–87, 9 illus.

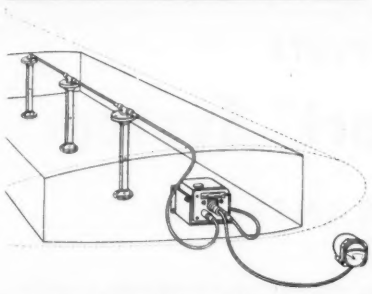

Illustration Courtesy Thomas A. Edison, Incorporated

Cutaway view of the Edison liquid gaging system installed in aircraft wing fuel tank. The center measuring device is at the c.g. of the mass when the tank is approximately level. The outer units are at c.g. of mass at the ends of the tank when the tank is tilted. The number and locations of the unit depend entirely upon the shape of the tank.

Viewpoints: Nose Wheels or Tail Wheels? The advantages and disadvantages of nose wheels and tail wheels are discussed in a two-section article. The first section sets forth the case for the nose wheel and the second the advantages of the tail wheel. *Air Trails*, July, 1946, pages 31, 112.

Lubrication

High-Temperature, High-Speed Testing of Lubricating Greases. J. F. Macphearson. The paper deals with the testing of greases for aircraft generators under conditions approximating those encountered in actual service. The tests were carried out at a plant of the General Electric Company as part of a grease-testing program instituted by the Army Air Forces and the Navy Bureau of Aeronautics. In these tests the actual apparatus to be lubricated was the test machine and the length of operation was approximately the service life of the machine itself. Details are supplied about the apparatus and the test procedure. The results of the tests are interpreted. An attempt to find a mathematical approach to the problem of lubrication life is described.

A summary of conclusions and the discussion that followed the reading of the paper are reproduced. *ASTM Bulletin*, May, 1946, pages 63–71, 12 illus.

Maintenance

Tune Up While You Tinker. Gilbert C. Close. Specific examples of upkeep and maintenance of light planes are presented in a manner intended to enable the pilot to increase the operational life, economy, and safety of his plane. Preservation of the paint and "dope" coatings on canvas surfaces is stressed. The problem of corroded metals is dealt with extensively, as well as several methods for removing and neutralizing corrosion of aluminum. *Western Flying*, June, 1946, pages 32, 33, 44, 6 illus.

Light Plane Surface Maintenance. Willis L. Nye. Drag-producing elements on light planes are described in an article dealing with maintenance of airplane surfaces. Inasmuch as the engine horsepower is often limited, no excess engine power should be expended in overcoming unnecessary drag caused by surface irregularities. Typical examples of surface imperfections and the methods for eliminating them are given. *Western Flying*, June, 1946, pages 34, 36, 1 illus.

Materials

Super Alloys for High Temperature Service. Harold A. Knight. The metallurgic requirements for alloys capable of withstanding the high temperatures and pressures occurring in gas turbines without distortion are considered. It is pointed out that the profligate use of expensive and scarce metals during a war is not within the realm of economics, and that the efficiency of alloys is the limiting factor that governs progress in gas-turbine development. The writer also discusses the comparative merits of forged and cast buckets, the evolution of high-temperature alloys, and jet propulsion problems. A table of the high-temperature alloys is included. *Materials & Methods*, June, 1946, pages 1557–1563, 3 illus.

Carbon Absorption of 18-8 Stainless Steel. Wilson G. Hubbell. An investigation carried out by the Ryan Aeronautical Company, to determine whether the stainless steel used for aircraft exhaust manifolds picks up carbon, which might affect the corrosion resistance of the metal, from the high-temperature exhaust gases, is reported. Microphotographs are reproduced, and carbon differences for several hot and cool operating areas of a number of burned-out manifolds are given. The results of the investigation indicate that there is a carbon pickup in exhaust manifolds during their service life, but that there is no substantial intergranular corrosion. *The Iron Age*, June 20, 1946, pages 56–59, 4 illus.

Medicine

The Effect of Ammonium Chloride on Altitude Tolerance. Alvan L. Barach, Morris Eckman, Emanuel Ginsburg, Artell E. Johnson, and Robert D. Brookes. The report gives particulars about an investigation that was carried out for the purpose of determining whether ingestion of ammonium chloride would be advantageous in counteracting the effects of anoxia at increased altitudes. Previous use of ammonium chloride was based on the theory that beneficial effects would be obtained at altitude because of the shift of the oxygen dissociation curve to the right.

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The effect of such a shift would be an increased delivery of oxygen to the tissues at comparable hemoglobin-oxygen saturations. The history of the subject is outlined and the methods followed in the investigation are described. The results obtained are analyzed and discussed. *The Journal of Aviation Medicine*, April, 1946, pages 123–136, 3 illus.

Physical Exertion in the Heat: Some Notes on Its Physiology and Hygiene. Capt. Craig L. Taylor. It is noted that the world-wide deployment of the armed forces has accentuated as never before the problems of physiologic adaptation to a variety of climates, and the practical concerns of clothing, protective equipment, and climatic hygiene. The physical, psychologic, and climatic factors underlying tolerance for exertion in the heat are considered. The results of some of the outstanding investigations of these phenomena are given. The concluding section deals with pertinent principles of hygiene. *The Journal of Aviation Medicine*, April, 1946, pages 137–145, 191, 3 illus.

Selection of Men for Aeronautical Training Based on Susceptibility to Motion Sickness. Major Allan Hemingway. The problem of selecting fliers with regard to motion-sickness susceptibility is reviewed on the basis of experience acquired in problems that have arisen in the selection of A.A.F. personnel. Four selection methods are examined critically and their usefulness is evaluated. Selection problems are discussed. *The Journal of Aviation Medicine*, April, 1946, pages 153–163, 2 illus.

The High Altitude Training Program for Fighter Pilots. Capt. Kenneth P. Wolfe. An analysis is made of the reactions of 2,275 fighter pilots noted during the routine Type 3 flight in a low-pressure chamber. It is explained that a Type 3 flight occupies about $2^1/_2$ hours of the 6-hour altitude-training program required of all fighter pilots assigned to the Fourth Air Force. The purpose of the flight is fourfold: first, to demonstrate to pilots the physical stresses and conditions they will encounter while flying at altitude; second, to teach the pilot the proper use of his oxygen equipment; third, to enable pilots to experience the physiologic effects of high altitude; fourth, to discover those pilots who have physical and mental characteristics that render them unsuitable as candidates for high-altitude missions. The predilection to reactions of certain physical types and age groups was observed and the effects of trauma, lack of sleep, ingestion of alcohol, and acute infections were noted. It is concluded that, on the basis of the physical examination and history prior to the flight, predictions can be made as to the type of reaction to be anticipated. *The Journal of Aviation Medicine*, April, 1946, pages 179–184.

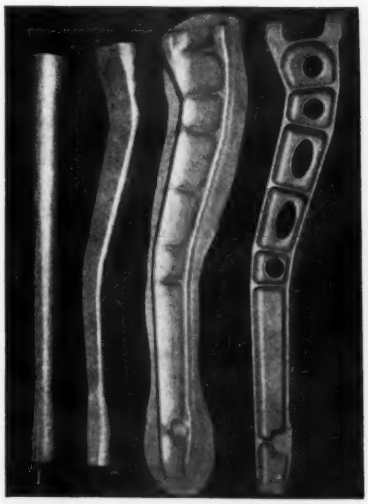
Metallurgy

Relative Significance of Design and Metallurgical Factors to the Serviceability of Magnesium Castings. George H. Found. Evidence from service experiences and from service-simulating fatigue tests of magnesium castings illustrates the relationship between subsurface microporosity and serviceability. It is shown by means of specific examples that design and the presence of microporosity or other defects at the metal surfaces have primary influence on serviceability of magnesium castings. *Aluminum and Magnesium*, June, 1946, pages 18–21, 30, 31, 12 illus.

Naval Aviation

Naval Aviation Looks Ahead. Vice Admiral Forest Sherman. The Deputy Chief of Naval Operations considers the importance, as well as the future, of air power in the Navy. Our modern air-sea Navy has specific plans for the continued use of its air forces. These plans involve eight essential features: (1) ready combat units; (2) reserve combat units; (3) strategic bases; (4) mobile tactical bases; (5) research and development; (6) strong commercial aviation; (7) an adaptable aircraft industry; and (8) national air-mindedness.

The writer states that we cannot have ready combat units if the aircraft industry is not stimulated to produce the most advanced equipment for combat aviation. The acquisition or maintenance of strategic bases depends upon political action fostered by national security consciousness and air-mindedness. The industry, in its turn, depends upon competitive research and development for its progress. The Navy's program for pilotless aircraft emphasizes the integrated character of "air-sea power." *Skyways*, July, 1946, pages 20–22, 56, 58, 2 illus.



Photograph Courtesy Wyman-Gordon Company

Four steps in the production of magnesium cargo-hoist forgings. The forging shown has a length of over 50 in. and weighs approximately 17½ lbs. It was produced from an AZ80X magnesium alloy in a 14,000-ton hydraulic press.

Performance

Flying the Dove. H. A. Taylor. The flying characteristics of the light transport, the de Havilland Dove, are described in detail, based on the writer's observations during a flight test of the airplane in which he was a pilot. He outlines the take-off procedure and describes the climbing speeds, approach and landing, and stalling characteristics of the craft. *Flight*, May 30, 1946, pages 548, 549. 2 illus.

Plant Equipment

Fire Fighting System for Engine Test Cells. Lee J. Bregenzer. The article gives details about a basic fire-fighting system for aircraft-engine test cells, which can be expanded to meet widely varying conditions. It is a carbon-dioxide piped system that is semiautomatic in operation. Plans and elevations of a test cell show the application of the equipment. *Aviation Maintenance & Operations*, June, 1946, pages 27–29, 2 illus.

Private Flying

"GCA and You." Lt. James W. Welsh. The following questions are answered in a general discussion dealing with the civilian application of Ground Control Approach equipment: What can G.C.A. do for me?; how does G.C.A. work?; what special gear must a plane have to make use of G.C.A.?; when will G.C.A. be available for civilian usage?; and, what will it cost? *Skyways*, July, 1946, pages 40, 41, 70, 4 illus.

Production

Contour Forming Solves Bending Problems. Because there are many cases where the power press is not satisfactory for reforming metal sections, the contour-forming process and a group of contour-forming machines described in this article have been developed by the Cyril Bath Company. It is explained that the process is particularly suited for aircraft work where it is necessary to form a constant section into curved shapes that must be held extremely accurately and where the cross section must be changed during the bending process. Difficult forming operations carried out by this process are described and illustrated. *The Iron Age*, June 6, 1946, pages 70, 71, 5 illus.

Properties and Limitations for Stepped and Tapered Extrusions. W. H. Arata. The advantages of stepped and tapered extrusions, as well as their limitations, are discussed.

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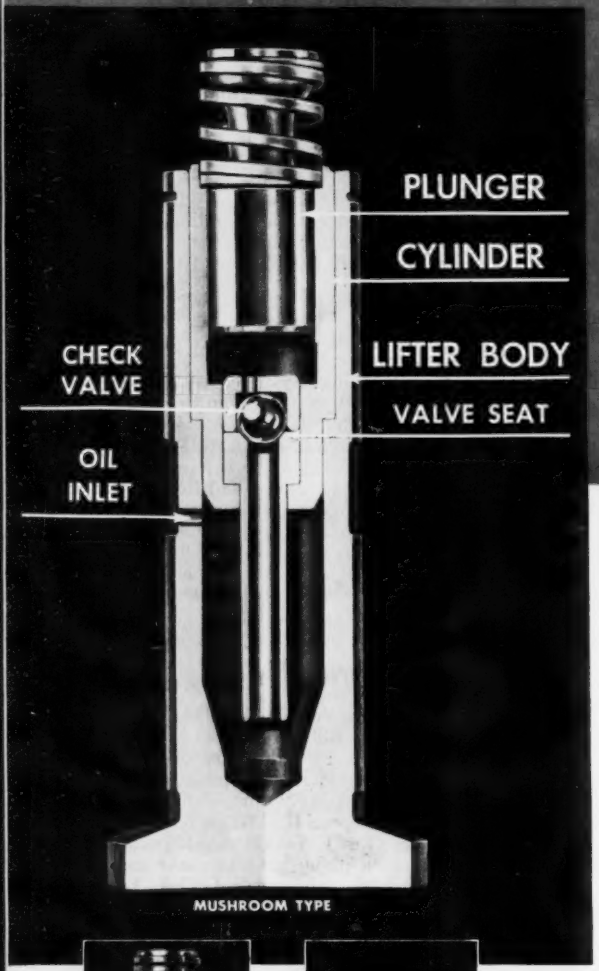

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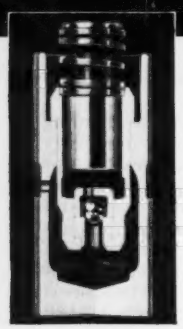

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Accurately determined clearance is provided between the plunger and cylinder wall permitting the escape of a small amount of oil from the chamber. This leakage automatically compensates for expansion in the valve train allowing for positive valve seating.

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Zero-Lash Hydraulic Valve Lifters are available in three basic types (mushroom, barrel, and stub) for all types of internal combustion engines—gasoline and Diesel.

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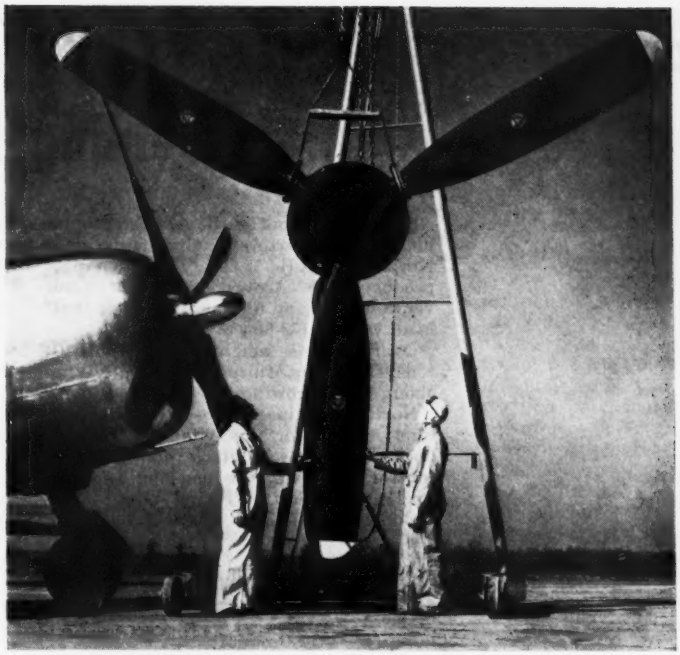
It is noted that stepped extrusions were originally developed to fulfill the need for blanks for spar caps that would require little machining. Tolerances and design data are supplied. The use of rolled billets is recommended for parts of larger sizes than those that can be made by the extruding process. *Product Engineering*, June, 1946, pages 487–491, 10 illus.

The Forging of Magnesium. Arnold L. Rustay and Franklin B. Rote. Research work leading to the development of methods for producing large magnesium forgings is described. It is observed that it was generally believed the forging of magnesium alloys must be done in hydraulic or slow-moving mechanical presses, and this practice limited the size of forgings because large presses were not available. The writer describes how a successful procedure was developed that combined the use of light hydraulic presses with mechanical presses and drop hammers. It is stated that the actual forging of large numbers of magnesium parts demonstrated that all of the standard magnesium alloys can be finish-forged under a hammer, provided the preliminary metal movement, which occurs in the blocking operation, is first accomplished in a hydraulic press. Relatively large magnesium forgings can be produced in this manner. Examples of magnesium forgings for aircraft are illustrated. *Machinery*, June, 1946, pages 141–148, 9 illus.

Joining Magnesium Alloys. Ordinarily, no adhesion can be obtained for metallic coatings to magnesium because of the ease with which it oxidizes. The article describes a patented method of joining or cladding metals, especially magnesium alloys, by the use of a metallic joining medium not in the liquid state. The primary object of the new method is to break down this oxide film by a mechanical process of abrasion, and it is stated that the basis of this is a consideration of the size of the abrading particles in relation to the thickness of the oxide film. The necessary condition is claimed to be satisfied if the surface of the magnesium in a preheated condition is rubbed by a pasty mass of alloy composition; for example, 1 part zinc, 4 parts cadmium, or 17 parts zinc, 134 parts cadmium. *Light Metals*, June, 1946, pages 291, 292.

Considerations Involved in the Accurate Development of Templates. A. Dickason. The article deals with the accurate development and layout of templates for repetition aluminum-alloy sheet work where "rule of thumb" methods are too slow. Conditions affecting the position of the neutral line are explained. Suggestions are supplied about the bending of duralumin and the development of templates for duralumin support brackets. *Sheet Metal Industries*, June, 1946, pages 1153–1155, 6 illus.



This 19-ft. diameter Curtiss electric propeller is designed to absorb 3,000 hp. and provide high cruising efficiency at substratosphere altitudes for the Convair B-36. The propeller blades are of hollow steel construction and are deiced by passing heated air through them. The propeller's mechanism incorporates provision for reversing the pitch if necessary.

Handling Magnesium with Safety. Harvey W. Johnsen. Successful methods used by a large magnesium foundry to combat fire hazards and accidents are described. The writer explains how molds that frequently blew up in the faces of pouroff men were controlled, water-wash booths were provided with ventilation to carry off magnesium dust, and operators were supplied with fireproofed clothing. The causes of magnesium fires and basic methods of extinguishing such fires are described. *Aluminum and Magnesium*, June, 1946, pages 14–17, 33, 2 illus.

Sand Casting in Aluminium Alloys. E. Carrington. Foundry techniques for the production of aluminum-alloy sand castings are described. Consideration is given to the properties required in molding sands. Molding systems and methods, and representative casting practices are discussed. Details are supplied about conditioning the sand, ramming the molds, the design of risers, and making molds on a machine. *Light Metals*, June, 1946, pages 281–291, 6 illus.

Propellers

Propeller Performance Analysis. Edwin Kessler. A short technical memorandum explains the derivation of equations by which the performance of a propeller may be calculated from its identifying coefficients. Conversely, it indicates that a propeller may be identified by four coefficients, the values of which are computed from the results of wind-tunnel tests. Curves plotted and coefficients computed for four propellers tested and reported in accordance with N.A.C.A. T.R. No. 650 are reproduced. A table shows the values of the coefficient of thrust as read from curves in that report, and below those figures are the values computed from an expression worked out by the writer, showing a maximum difference of 2 per cent between the actual and the calculated values. A relationship is perceived between the physical characteristics of the blades and the values of certain coefficients, indicating that coefficients could be used by the airplane designer to specify the desired aerodynamic characteristics of a propeller, and the blade designer would be able to produce a propeller having the desired coefficients. It is indicated that the expressions for thrust coefficient and efficiency can also be used for calculating airplane performance at varying speeds, and that if the drag is expressed by a total effective drag coefficient, then both the power available and the power required are obtained by expressions containing only density and air speed as variables. *Aero Digest*, June, 1946, pages 80, 81, 106, 4 illus.

Radio

Blind Landings—Bluff. Lt. Col. Patrick R. Arnold. The writer, who has made a total of 700 instrument approaches, outlines the method that he considers the most practical for accomplishing this "blind" letdown. The necessary factors include (1) a 40-

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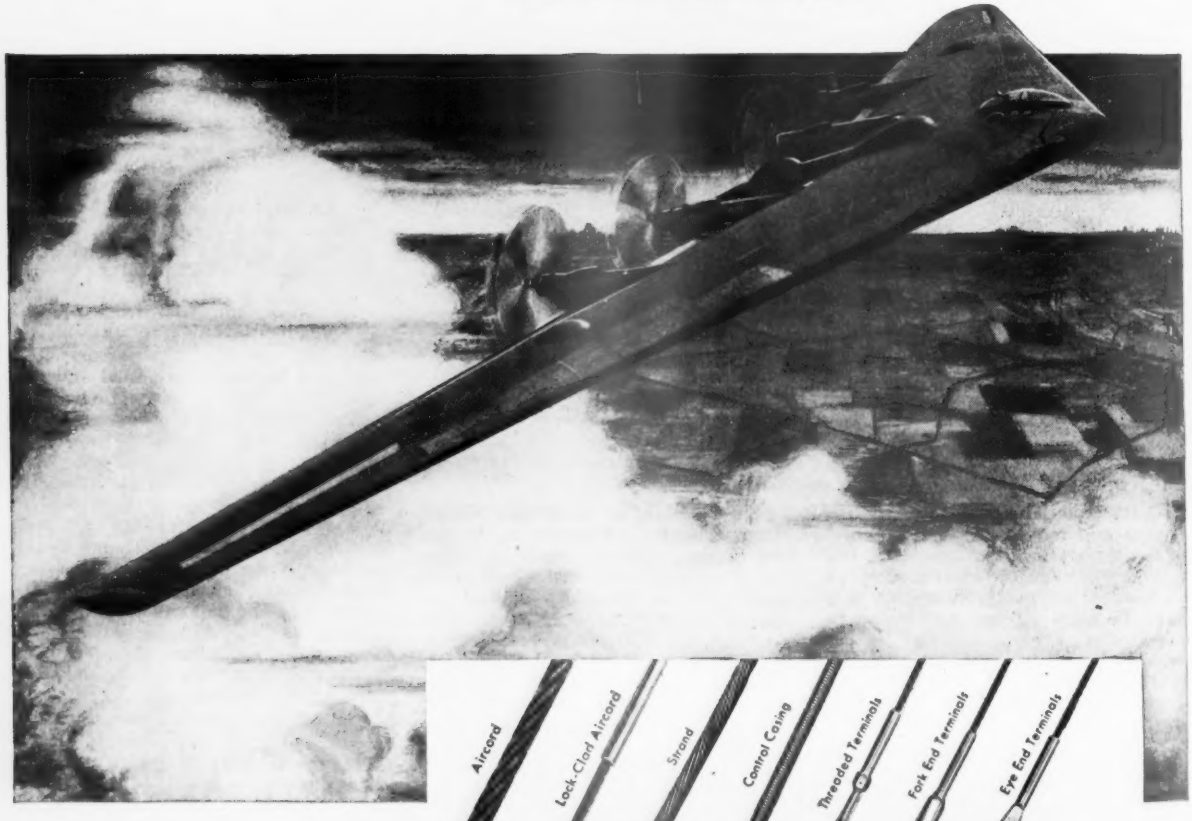


Other Roebling Aircraft Products include Wire Rope, Slings, Electrical Wires & Cables

ROEBLING

PACEMAKER IN WIRE PRODUCTS

lb. localizer in the aircraft, as well as glide-path and indicator equipment; (2) a runway with an obstruction-free approach, localizer, and glide-path installation; (3) two or three Aerophare markers. For a detailed explanation of the method used in the Alaska-Aleutians area the writer uses the rectangular pattern of traffic and approach. This method is diagrammed, with explanations in chronologic order of procedure. *Air Transport*, June, 1946, pages 51, 53, 1 illus.

Aero Digest's Sampler Chart of Personal Aircraft Radio. Lawrence LeKashman. A tabulation presents information regarding available personal-aircraft radios. There are approximately 75 headings, designed to provide quick comparisons between the qualifications of the various sets. Besides its value in comparing the various radios with respect to specifications and performance data, the chart is intended to be useful in tracing certain general relationships. The 63 models listed are arranged in ascending order according to size. Pictures of all the sets are shown on the two pages following the chart. A general discussion of private-plane radios accompanies the chart and photographs. *Aero Digest*, June, 1946, pages 39–43, 110, 63 illus.

Reconversion

Canso Conversion. The conversion of war surplus Canso PBY5A amphibians for commercial use is reported in an article describing the modifications involved and the general performance data of the aircraft. Converted at the St. Laurent plant of Canadian Car & Foundry Company, one craft is reported to have been sold to a South American petroleum company for ferrying oil-field equipment and personnel within South America. At sea level, four tons of pay load plus a crew of four can be accommodated, and a two-ton pay load can be lifted from a field 10,700 ft. above sea level. The modifications made in the airplane are listed. *Canadian Aviation*, June, 1946, pages 46, 112, 4 illus.

Rotating Wing Aircraft

Helicopter Performance. Robert L. Lichten. A straightforward method for calculating helicopter performance is developed which retains the accuracy of the blade-element approach yet is not prohibitively lengthy.

Expressions are presented for the flapping, thrust, longitudinal-force, and power coefficients of a hinged-blade lifting rotor, which include the effect of linearly tapered and twisted blades. These expressions have been simplified for use by presenting them as simple functions of the inflow ratio and the blade pitch angle, having numerical coefficients. Tables of the necessary numerical coefficients that are satisfactory for most applications are presented in an appendix.

Performance is expressed in terms of the climb ratio, an expression for which is developed based on the force equilibrium existing in steady flight. The climb ratio may be presented for a given helicopter in a series of charts covering the speed range. These charts will express the complete performance of the helicopter. A cross-plot from these charts yields a single chart that expresses the complete level flight performance. Included in the paper are examples of such charts, a comparison between the calculated and flight-test performance of a helicopter, and curves showing the effects on performance of various changes in an example helicopter. *Journal of the Aeronautical Sciences*, July, 1946, pages 353–363, 9 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Rotary Winged Engineering Advancement. Major Ernest M. Cassell, Jr. A compilation of tests and findings on the Sikorsky YR-5, R-5A, and R-5D helicopters is included in a general discussion revealing the engineering advancements in helicopters. Improvements and modifications adopted as the result of experience with the different models are outlined. *American Helicopter*, June, 1946, pages 24, 25, 27, 3 illus.

Design and Flight Characteristics of the Flettner Fl-282 Helicopter. The writer analyzes the design and performance of the Flettner F1-282, a German helicopter that is said to have been flown more miles than any other helicopter built in Germany. It is stated that the vertical climb of this aircraft is 300 ft. per min. The maximum speed in level flight is 90 m.p.h., and the hovering ceiling is estimated to be about 1,000 ft. It is reported to be extremely maneuverable. Sections of the article are devoted to the stability of the aircraft, vibration characteristics, and details of design. The important specifications and rotor characteristics are listed in a table. *Aviation*, June, 1946, pages 60–64, 6 illus.

Helicopters Are Commuter Specials. N. F. Silsbee. Several types of helicopters are briefly described with regard to their relative advantages and disadvantages. The writer refers to the conversion of wartime helicopters to commercial use, and proposes ideas for their participation in commercial aviation. The fundamental principles of helicopter flight are set forth. *Skyways*, July, 1946, pages 48–51, 90–93, 7 illus.

Coast Guard Helicopter Program. An article discussing the helicopter's activities in the Coast Guard outlines the proposed program under the following classifications: training units; operational testing and development units; overhaul and spare-parts center; operational units for the interior of the United States; and helicopter units assigned to ships. The activities of some of the Coast Guard air stations and the influence on future helicopter design caused by recent Coast Guard experiments are listed. It is estimated that 50 per cent of the future aircraft operated by the Coast Guard will be helicopters. *American Helicopter*, June, 1946, pages 10, 11, 26, 27, 3 illus.

R.I. Firm Develops Two Utility 'Copters. Brief descriptions are supplied about two small helicopters designed for low-cost, ease of operation, and utility, which are being developed by the Helicopter Engineering & Construction Corporation, East Providence, R.I. They are designated as Model 100 and Model 101, the first being a single-place aircraft and the second designed to seat two. It is stated that a top speed of 100 m.p.h. is contemplated for the Model 100, which will have a steel-tube fuselage, covered with light plywood skin and fabric. A Continental A-75-9 engine developing 75 hp. at 2,300 r.p.m. will be mounted just behind the cabin. A fixed tricycle landing gear is to be utilized. *Aviation*, June, 1946, page 91, 2 illus.

Stress Analysis

An Analogy Among Torsional Rigidity, Rotating Fluid Inertia, and Self-Inductance for an Infinite Cylinder. John W. Miles. In carrying out flutter and stability calculations, it is often desirable to know the inertia of a wing containing fuel. The added inertia of the fuel in translation for a full tank may be taken as if the fuel were solid, but, inasmuch as normal fuels are characterized by small viscosity, the rotational inertia is smaller than it would be if the fuel were solid. A theoretic calculation of the rotational inertia for a perfect fluid is made.

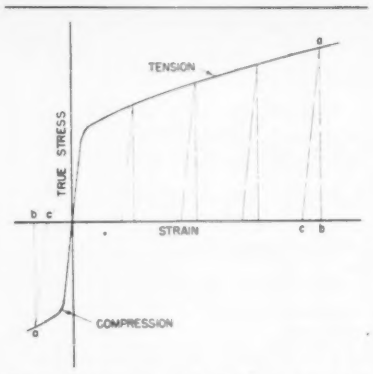
It is shown that the cross-sectional, polar moment of inertia of any cross

section containing a perfect fluid is given by subtracting from the polar moment of inertia of the cross section (as a rigid body) the torsional rigidity of the cross section, the latter being calculated as though the cross section were perfectly elastic with a shear modulus of unity. Results are given for an ellipse, an equilateral triangle, an isosceles right triangle, and a rectangle. References are included from which results for various other shapes may be obtained. *Journal of the Aeronautical Sciences*, July, 1946, pages 377–380, 1 illus.

Dynamic Loads in Airplane Structures During Landing. Shou-Ngo Tu. The additional dynamic loads introduced by vibrations excited by the impact load in landing may create a critical design condition for the structures of an airplane. In this paper, a method is developed to estimate the magnitude of these loads in the wing for the two-wheel landing condition. The wing is found to vibrate in such a manner that the points of attachment of the landing gear are always two of the node points. This fact gives a guide to determine the coupled modes and frequencies. Formulas are derived then to show the relative contributions of various modes to the resultant motion. By calculating the inertia loads and moments from the accelerations thus determined, the beam shear and bending moment can be easily evaluated. *Journal of the Aeronautical Sciences*, July, 1946, pages 381–387, 2 illus.

Failure of Ductile Metals in Tension. G. Sachs and J. D. Lubahn. It is stated that an examination of aluminum-alloy sheet fabricating methods in the aircraft industry reveals lack of fundamental knowledge regarding the phenomena that explain the performance of metals under various stress and strain states. Previous investigations appear to have neglected entirely both the effects of the geometry of the part and the fact that the strength of the metal and limit of forming are frequently determined by a process of instability, or "necking," rather than by the process of fracturing. A theory of necking is developed in order to predict the forming limits for various stress or strain states based upon an analysis of the true stress-strain curve in pure tension. A criterion for necking is advanced, based upon the maximum-load (or pressure) conception of instability, and is applied to different geometric shapes formed at room temperature. *Transactions of the A.S.M.E.*, May, 1946, pages 271–276, 7 illus.

The Necking of Tensile-Test Specimens. J. D. Lubahn. The second of three related papers states that the significance of the phenomena encountered in tensile tests for the evolution of structural metals with regard to their relative performance in forming and their strength in service appear to be little understood despite numerous investigations. A detailed



Stress-strain curve and springback in tension and pressure.

investigation of the strains encountered in long rectangular tensile-test bars of 24S-O and 24S-T aluminum alloy is described. The experiments confirm theoretic concepts previously advanced by G. Sachs and J. D. Lubahn. *Transactions of the A.S.M.E.*, May, 1946, pages 277–279, 5 illus.

Instability of Thin-Walled Tubes Subjected to Internal Pressure. G. Espey. The writer presents an experimental analysis to support the theoretic conception advanced by G. Sachs and J. D. Lubahn for the necking of tubing subjected to pure longitudinal tension, to balanced biaxial tension, and to plane strain with the major strain being circumferential. It also shows that the stress-strain curve in uniaxial tension can be used to predict the necking strain for tubing under various stress states. *Transactions of the A.S.M.E.*, May, 1946, pages 281–285, 11 illus.

The Stressing of Cabins Under Uniform Pressure. E. W. H. Thompson. As an approach to the determination of the end loads, shears, and bending moments induced by uniform pressure in a cabin former ring of any odd shape, an analysis is made of how these forces vary in a cabin ring according to changes in the space parameters of cabins of simple mathematical form. The condition of a cabin subjected to uniform internal pressure only is considered. *Aircraft Engineering*, May, 1946, pages 155–159, 10 illus.

Local Stress Distribution in Cylindrical Shells. Leon Beskin. It is noted that the stress distribution in cylindrical shells with light frames is considerably different from the conventional beam distribution in the neighborhood of the applied loads. The problem is examined for circular cylinders with circular frames of constant section. The case of an indefinite shell with one loaded frame is examined in detail, and diagrams are given for the following unit conditions: concentrated radial force; tangential force; couple. *Journal of Applied Mechanics*, June, 1946, pages A-137–A-147, 7 illus.

Distortion Due to Contour-Forming of Extrusions and Preformed Sheet-Metal Sections. William Schroeder. The effect of springback on the radius of curvature due to contour forming of extrusions or preformed sheet-metal sections is analyzed. A number of the commonly used methods of forming are considered. Equations for computing values for change in radius are derived and sample calculations are compared. *Transactions of the A.S.M.E.*, May, 1946, pages 287–292, 8 illus.

Superchargers

Turbosupercharger Overhaul. A. R. Kelly. An article explaining the overhaul procedure used on the turbosupercharger includes the following list of parts to be checked: the bucket wheel, should be checked for nicks and dents; the shafts, must be inspected for damage and undersized bearing journals; bearings, checked for mechanical damage or pickup from the shaft; the waste gate, should be straightened if bent; the bearing-and-pump casing assembly, cleaned; the oil pump, may need to be replaced; impellers having cracks are replaced; rotor is balanced; and excessive vibration is eliminated. *Aero Digest*, June, 1946, pages 48, 49, 125, 7 illus.

Testing

A Method of Testing Thin Sheet Material in Compression. Baxter C. Madden, Jr. A method of determining the compressive mechanical properties of thin sheet material is presented. The test jig, specimen, and details of the testing procedure are described, and the detection of buckling and the measurement of friction between the specimen and the jig are discussed. As a rule, this friction is low enough to be ignored but may be readily determined for each specimen. Results of tests by the "pack" method, the "cylinder" method, and the method described, on 0.035-in. thick steel, are given. These indicated good agreement among the three methods. Tests on 0.040-in. thick R301-T aluminum alloy showed consistent results from specimen to specimen. Results of tests of 0.020-in. thick clad 24S-T and 0.016-in. thick clad 75S-T aluminum alloys are also given. Test results are presented as stress-strain diagrams. Ease of specimen preparation, simplicity of the jig, and the assurance of low friction between the specimen and its supporting plates are advantages of the test method described. *Journal of the Aeronautical Sciences*, July, 1946, pages 346–352, 12 illus.

Testing Equipment

Tension Testing at Elevated Temperatures. T. M. Blackmon, P. R. Nourse, and E. H. Plesset. The writers describe a simple and inex-

pensive method of heating tension specimens by resistance heating, and also a method of measuring specimen temperatures. They also give particulars about two types of extensometers and associated equipment which have been developed for use with a Baldwin-Southwark recorder. One extensometer is a rework compressometer for use in the elastic range. The other is designed to measure elongations up to 50 per cent of a 2-in. gage-length for studies in the plastic range. It is stated that the tension specimen may be broken without damaging the plastic-range extensometer. A technique for determining the true load at fracture of ductile specimens is described. *A.S.T.M. Bulletin*, May, 1946, pages 32–37, 14 illus.

Design of a Refrigerated Altitude Chamber. Charles J. Lyall. Particulars are given about a program of North American Aviation, Inc., established for the development of better high-altitude chamber equipment. The history of testing-chamber design is outlined, and the construction requirements for a reinforced concrete refrigerated altitude chamber are stated. The equipment and instruments are detailed, with the reasons for selecting the types and capacities chosen. The major advantages of the design developed through this research work are enumerated. *Mechanical Engineering*, June, 1946, pages 537, 538, 1 illus.

Welding

An Investigation of the Fatigue Strength of Spot Welds in the Aluminum Alloy Alclad 24S-T. W. F. Hess, R. A. Wyant, F. J. Winsor, and H. C. Cook. The work described in this report was carried out at the Rensselaer Polytechnic Institute for the purpose of evaluating, from the standpoint of repeated stress, some of the results obtained in other parts of an experimental program. The single-spot lap-weld type of specimen was used in all of the studies. The tests consisted of repeatedly varying the load on these specimens from fixed minimum values of 10, 30, and 50 per cent to specific higher percentages of the static shear strength until failure occurred. Studies were made to determine how the performance of this type of specimen is affected by the following factors: (1) weld size or static shear strength; (2) weld quality as evidenced by soundness or by cracking revealed by radiographs; (3) surface treatment prior to spot welding; (4) thickness of material; (5) unequal thickness combinations. The investigation showed that the most important of the factors was the size of the spot weld. *The Welding Journal*, June, 1946, pages 344-s–358-s, 31 illus.

How to Weld Aluminum. Parts I and II. These are the first two installments of a four-part article in which modern techniques employed in welding aluminum, including gas, carbon, arc, metallic arc, atomic hydrogen, and resistance welding, and also brazing and soldering, are reviewed. In Part I, details about the weldability of various aluminum alloys are given and particulars are supplied about gas-welding techniques. Tables contain data on the normal mechanical properties for aluminum sheet products, torch welding data for aluminum of various thicknesses, welding-rod sizes for different thicknesses of plate, and data on the minimum tensile strength of gas-welded aluminum alloys.

In Part II, methods of arc welding aluminum parts are discussed. Consideration is given to carbon arc welding, atomic hydrogen arc welding, and inert-gas shielded arc welding. *The Iron Age*, June 20, 1946, pages 50–55, 5 illus.; June 27, 1946, pages 60–64, 6 illus.

The Welding of Non-Ferrous Metals. Part VII. E. G. West. In a continuation of a serial article on nonferrous metal welding, some concluding statements are made regarding aluminum brazing and the subject of welding of magnesium alloys is taken up. The information about aluminum brazing includes a discussion of oxy-gas, furnace, dip, and electric brazing processes. In considering the welding of the magnesium alloys, the writer first gives particulars about the weldability of these alloys. He then outlines the processes for welding magnesium and explains details of the oxy-gas welding method. *Sheet Metal Industries*, June, 1946, pages 1168–1172, 4 illus.

Impact Strength of Arc Welds. H. O. Klinke. An investigation was conducted recently on the impact strength of metallic-arc-welded butt joints in SAE X-4130 steel. Several ferritic and austenitic type filler metals were used and impact strengths ascertained in both the as-welded and heat-treated condition. The type of impact specimen selected was the simple beam type (Charpy) with a keyhole notch. The notch was variously located in the weld metal; at the boundary of the weld metal and the parent metal; and in the parent metal. The purpose of the investigation was to illuminate one phase of the nonstatic behavior of welds and weld boundaries in X-4130 steel as used in the aircraft industry. A description of the procedure is supplemented by a tabulation showing the results. *Aero Digest*, June, 1946, pages 82, 83, 1 illus.

Fundamentals Affecting the Bond in Pressure Welds. Leslie Fine, Charles H. Maak, and Anthony R. Ozanich. Factors influencing the bond in pressure welds are analyzed. The study is particularly concerned with pressure welding as applied in the construction of aircraft landing gear. Means of determining the character of pressure welds are outlined. Sections are devoted to the theoretic aspects of bonding, plastic deformations caused by upsetting and surface energy, weld contaminates, and physical testing as a means for differentiating weld quality. *The Welding Journal*, June, 1946, pages 517–529, 30 illus.

The Practical Significance of Recent Work on the Pressure Welding of Light Alloys. R. F. Tylecote. Some interesting results obtained during the course of investigations on the pressure welding of light alloys are described. Particulars are supplied about pressure-welding principles and technique, the strength of pressure-welded joints, and pressure welding applications. *Sheet Metal Industries*, June, 1946, pages 1165–1167, 1178, 3 illus.

Miscellaneous

Four Methods for the Solution of Simultaneous Linear Equations. Robert H. Scanlan and Marvin G. Harrison. The article deals with the solution of simultaneous linear equations by methods based on elimination, matrices, a tabular technique, and relaxation. Calculation forms are given for the practical computer. A brief review of some properties of matrices are included. Operational procedure is illustrated with the solution of two sets of equations containing four unknown values. *Product Engineering*, June, 1946, pages 513–515.

Fuel-carrying economy is in the bag

THERE are no expensive "frills" on practical small airplanes such as the Republic Seabee. Every component has to pay its own way in utility, long life, and easy maintenance. Cost *is* an object.

B. F. Goodrich bladder-type fuel cells fit right into this economy picture. By preventing gasoline leakage-through-the-skin (which can happen with metal gasoline compartments), these cells add a new factor of safety and save many hours of maintenance.

Production line economies are important cost cutters. Installation of B.F. Goodrich bladder cells is a simple matter of folding them up, pushing them into the tank cavity and snapping them into place with built-in fasteners.

B. F. Goodrich builds these cells in layers of synthetic rubber and nylon fabric. They are specially designed for toughness and high abrasion-resistance, yet they are completely flexible. Cells have been developed covering weight and strength requirements for all types of airplanes . . . from paper-thin tanks for light loads to high-strength, large volume tanks for big transports. All guard against leakage; all add shock resistance; all hold down maintenance.

B. F. Goodrich cells should be designed into new ships; they can be adapted to many ships now flying. For facts, write to *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

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FIRST IN RUBBER

Government Publications

Army Air Forces

The Stability of Compressible Flows and Transition Through the Speed of Sound. A theoretic investigation of the stability of steady compressible flows, particularly at a "transition line" where the fluid velocity equals the speed of sound, is reported. The differences between supersonic and subsonic flow are explained, and the known flows containing both supersonic and subsonic regions are described. Since compressible flows are always reversible in the absence of shock waves, transitions from subsonic to supersonic flow and from supersonic to subsonic flow are in theory equally possible. But experiments in a contracting-diverging nozzle have shown that transition in accelerated flow can be established easily, whereas transition in decelerated flow apparently has never been. This result has been confirmed by observations on the supercritical flow over airfoils. Hence, it has been conjectured that any steady transition from supersonic to subsonic flow is unstable. The present report is an investigation of the validity of this conjecture.

Physical proofs of the conjecture are given for the case of flow in a nozzle, followed by a mathematical analysis based on the approximate equations for unsteady flow. A general analysis of stability criteria is presented, the stability of both the nonlinear and the linearized equations of motion is investigated, and the results are compared. A satisfactory proof for instability of a transition in decelerated nozzle flow is obtained and strong indications are found that a transition in accelerated flow is stable.

A physical proof is given of the general conjecture in the modified form: A transition from supersonic to subsonic flow is unstable provided the lines (planes) of constant velocity are approximately perpendicular to the streamlines. Hence it follows that shock-free flow over an airfoil with appreciable supersonic regions is unstable. The theory of stability for flows in which the lines of constant velocity are oblique to the streamlines will be presented in a later report. For such flows the following conjecture is made: A decelerated flow is unstable wherever the velocity component normal to the lines of constant velocity is equal to the speed of sound. *Air Matériel Command, A.A.F. Technical Report No. 5410,* January 14, 1946.

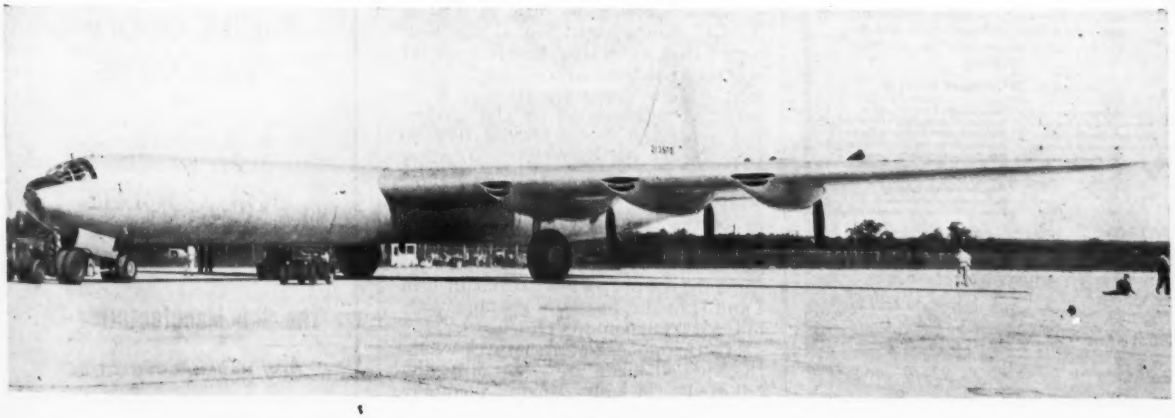
XB-36, A.A.F.'s Newest Bomber. Construction of what is said to be the world's largest land-based bomber, the XB-36, has been completed at the Fort Worth plant of Consolidated Vultee Aircraft Corporation and a 5 to 6 weeks' ground-test program has been initiated. Initial flights of the new bomber are not scheduled until later in the summer, the date depending upon the progress of the ground and taxi tests.

Upon completion of the tests, the new airplane will be assigned to the Strategic Air Command, which has the responsibility of planning and executing all A.A.F. commitments requiring long-range and heavy bombers. The XB-36, designed and constructed under the supervision of the Air Matériel Command, is powered by six Pratt & Whitney 3,000-hp. engines. It has a wing spread of 230 ft. and a fuselage length of 163 ft. Pusher-type propellers are set into the after part of the wing. The XB-36 requires a crew of 15, who are accommodated in pressurized compartments.

The Air University represents a new period of military aviation. It will embody some novel trends insofar as its educational program is concerned, including in its curricula the most up-to-date knowledge available on every phase of aerial warfare. Ground work is being laid preparatory to the beginning of classes in the various units of the University, the first of which will start in September when the Air War College and the Air Command and Staff School receive their first students.

Under its present physical status, the Air University consists of an Air War College, an Air Command and Staff School, an Air Tactical School, Special Staff School, and the A.A.F. School of Aviation Medicine, located at Randolph Field, Tex. Present plans call for the Air Command and Staff School and the Air War College to be located at Maxwell Field, Ala.; the Special Staff School at Craig Field, Selma, Ala.; the Communications Course of the Special Staff School at Gunter Field, Montgomery, Ala.; and the Air Tactical School at Tyndall Field, Panama City, Fla. Opening date for the Air War College and the Air Command and Staff School is September 3.

Consolidated Vultee's XB-36.



Operating directly under the Commanding General of the A.A.F. as a major command, the Air University will coordinate the curriculum of the Air Institute of Technology at Wright Field, Ohio, and will maintain close liaison concerning new developments in aviation with the other major A.A.F. commands. Instructors of the Air Command and Staff School are preparing courses in their respective subjects, which include administration, personnel, public relations, research and development, logistics and services, tactics, strategy of employment, communications, air power, air defense, reconnaissance, ground forces, naval warfare, amphibious operations, and others.

Students at the Air Tactical School will receive theoretic and practical instruction covering the most effective organization, tactics, and techniques of fighter, bombardment, reconnaissance, and pathfinder aviation, guided missiles, and unmanned aircraft. At the same time these junior officers will be trained for squadron command duties and staff duties appropriate to the squadron grades. Special emphasis will be placed on stimulating development of improved methods for tactical employment of current and new equipment and to achieve an understanding of the basic factors that dictate operations in the air, on the ground, and on the sea.

In the Air Command and Staff School, students will be given that type of instruction that will prepare them for the command of groups and wings and for staff duties appropriate to these grades. The scope of instruction will include organization and employment of the group and larger aviation units, tactical coordination between fighter, bombardment, reconnaissance, and transport aviation, and with ground and naval forces, organization, and functions of air defense installations, in coordination with antiaircraft artillery units.

The Air War College will prepare selected officers for command and staff duty with higher air units. In this highest of the Air University's schools and colleges, the students will study organization, characteristics, and strategic and tactical employment of Air Forces and larger air units, the selection of target systems, targets and aiming points, strategic considerations concerning defense against air attack with particular emphasis upon possibilities inherent in new developments, and the effects of the application of atomic energy to air warfare. Conducted along the lines of current and future trends, the Air War College will encourage the study of new developments and their implications concerning future aerial warfare, involving both offensive and defensive measures.

Associate courses of approximately 3 months' duration are being planned and incorporated into the curriculum of the Air University's schools for the benefit of National Guard and Reserve officers on inactive status who could not otherwise avail themselves of the University's educational opportunities. *Air University*, Maxwell Field, Ala.

Civil Aeronautics Administration

Interpretation of CAR 03.310 and New CAR 04.310. The sections referred to specify that strength properties shall be based on a sufficient number of tests of material conforming to specifications to establish design values on a statistical basis; also, that the design values shall be so chosen that the probability of any structure being understrength because of material variations is extremely remote.

With reference to Section 5.00 of ANC-5, Amendment No. 1, it will be noted that allowable design property columns headed "Army-Navy" represent design properties that will be equalled or exceeded by the properties possessed by approximately 90 per cent of the material. All other allowable design property columns relate to the minimum guaranteed properties and are based on values given in the various material specifications. The permissible uses of these design properties are outlined in I and II below, based on the objectives of CAR 03.310 and CAR 04.310.

(I) In the case of structures where the applied loads are eventually distributed through single members within an assembly, the failure of which would result in the loss of the structural integrity of the component involved, the guaranteed minimum design mechanical properties listed in ANC-5 should be used. Typical examples of such items are (1) wing lift struts; (2) spars in two-spar wings; (3) spar caps in regions such as wing cutouts and wing center sections where loads are transmitted through caps only; (4) primary attachment fittings dependent on single bolts for load transfer.

(II) Redundant structures wherein partial failure of individual elements would result in the applied load being safely distributed to other load-carrying members may be designed on the basis of the "90 per cent probability" allowables. Typical examples of such items are (1) sheet-stiffener combinations; (2) multirivet or multiple-bolt connections.

Certain manufacturers have indicated a desire to use design values greater than the guaranteed minimums even in applications where only guaranteed minimum values are permitted, and have advocated that such allowables be based on "premium selection" of the material. Such increased allowables will be acceptable provided that a specimen or specimens of each individual item are tested prior to their use, to determine that the strength properties of that particular item will equal or exceed the properties to be used in design. This,

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Maryland Casualty Company
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Travelers Insurance Company
Aetna Casualty & Surety Company
American Surety Company of New York
Hartford Accident & Indemnity Company
Massachusetts Bonding & Insurance Co.
New Amsterdam Casualty Company
Standard Accident Insurance Company
Standard Surety & Casualty Co. of N. Y.
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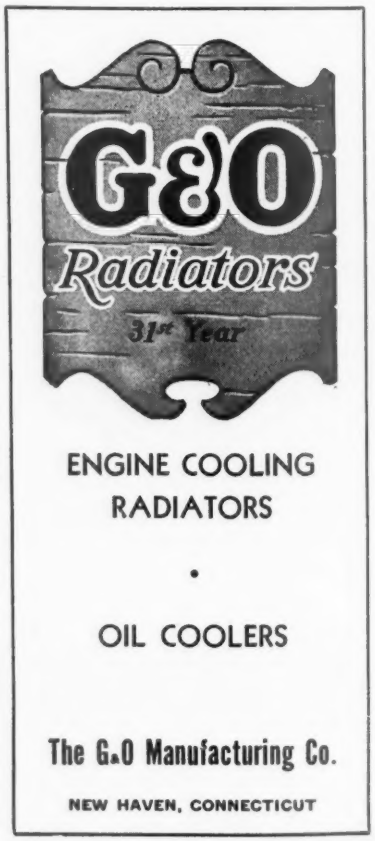

in effect, results in the airplane or materials manufacturer guaranteeing higher minimum properties than those given in the basic procurement specifications.

When strength testing is employed to establish design allowables (such as in the case of sheet-stiffener compression tests), the test results should be reduced to values that would be met by material having the design allowable material properties for the part under consideration, as covered in I and II above. Sections 1.543 and 1.544 of ANC-5 outline two means of accomplishing this, but are by no means considered as the only methods available. *Safety Regulation Release No. 206*, May, 1946.

Cross-Wind Landing Gear. Cross-wind landing gear for small high-wing airplanes will be investigated, and perhaps developed, under a contract recently signed between the Goodyear Aircraft Corporation and the Civil Aeronautics Administration.

Cross-wind gear has been installed on a PT-19 under a C.A.A. experimental contract with the Fairchild Engine and Airplane Corporation. The PT-19 has shown excellent landing and take-off characteristics in test flights, although problems connected with taxiing still are under study. Equipment of the PT-19 type could then be readily developed for use on any low-wing plane in which the landing gear is attached to the wings.

The contract with Goodyear is intended to develop landing gear for small planes in which the undercarriage is attached to the fuselage. The Government will provide an Army surplus Piper J-3 for the Goodyear experiments. These experiments will be conducted in three steps. First will be construction of a towing test rig in which the wheels will caster freely up to 30°, turning on an axis within the wheel hubs. Motion pictures will be made of the towing tests at speeds of 25 to 60 m.p.h.

When what appears to be a satisfactory gear has been developed for the tow rig, an experimental gear will be installed on the Piper for taxi and flight tests. As the tests continue, necessary modifications will be made in this gear. If the first two steps produce a satisfactory cross-wind gear, Goodyear will deliver the airplane with its new equipment to the C.A.A. for demonstration purposes.

The Goodyear contract calls for expenditure of about $23,000 and completion of the work in 7 months. Any patents resulting from the experiments will be the property of the U.S. Government. The work is being done under a Congressional appropriation of $150,000 for this phase of developing a better personal airplane.

John H. Geisse, C.A.A.'s Assistant to the Administrator for Personal Flying Development, stated that similar contracts for experiments on tricycle landing gear will be negotiated in the next few months if funds are available. *Office of Aviation Information*,

National Advisory Committee for Aeronautics

Two - Dimensional Irrotational Mixed Subsonic and Supersonic Flow of a Compressible Fluid and the Upper Critical Mach Number. Hsue-Shen Tsien and Yung-Huai Kuo. The problem of flow of a compressible fluid past a body with subsonic flow at infinity is formulated by the hodograph method. The solution in the hodograph plane is first constructed about the origin by superposition of the particular integrals of the transformed equations of motion with a set of constants which would determine, in the limiting case, a known incompressible flow. This solution is then extended outside the circle of convergence by analytic continuation.

The previous difficulty of the Chaplygin method of slow convergence of the series has been overcome by using the asymptotic properties of the hypergeometric functions so that numerical solutions can be obtained without difficulty. It is emphasized that, for a solution covering the whole domain of the field of flow, both fundamental solutions of the hypergeometric differential equations are required.

Explicit formulas for numerical calculations are given for the flow about a body, such as an elliptic cylinder, and for the periodic flow such as would exist over a wavy surface. Numerical examples based on the incompressible flow solution of an elliptic cylinder of thickness ratio of 0.6 are computed for free-stream Mach Numbers of 0.6 and 0.7.

The results of this investigation indicate an appreciable distortion in the shape of the bodies in compressible flow from that of incompressible flow, which necessitates a series of computations with various values of the geometric parameter in order that the desired body shapes can be selected for a given Mach Number. It also is shown that the breakdown of irrotational flow depends solely upon the occurrence of limiting lines, which, in turn, are dependent on the boundary conditions.

The numerical calculations show that at a free-stream Mach Number of 0.6, irrotational supersonic flow exists up to a local Mach Number of 1.25, whereas breakdown occurs at 1.22 for a Mach Number of 0.7. *Technical Note No. 995*, May, 1946.

The Theoretical Flow of a Frictionless, Adiabatic, Perfect Gas Inside of a Two-Dimensional Hyperbolic Nozzle. Howard W. Emmons. The two-dimensional flow of a frictionless, adiabatic, perfect gas inside of a two-dimensional hyperbolic nozzle has been studied by numerical methods described in N.A.C.A. Technical Note No. 932. A series of solutions is presented which show an almost continuous transformation of known subsonic solutions to the known subsonic-supersonic solution. The words "almost continuous" are used because difficulties at the point where the shock waves touch the wall seem to prohibit continuous transformation from one type of solution to the next.

Solutions with partial shocks, that is, shock waves that do not extend all the way across the nozzle, are hard to obtain. Residuals of one part in one thousand can sometimes be eliminated only by introducing a shock. The type of solution obtained is therefore extremely sensitive to small changes in nozzle form. The solutions are not single-valued, in general, in the relation of flow through the nozzle to pressure at a given point in the nozzle. In experiments, the flow might make small jumps as the type of flow pattern passes through unstable regions.

A few Schlieren photographs show that the actual flow through this nozzle differs considerably from the computed solutions. All the differences can be ascribed to the effects of friction. Since the flow pattern in the nozzle is extremely critical in the slightly supersonic regions, the phenomena would be greatly altered if a boundary layer were included in the computation.

It has been known for some years that the perfect fluid theory was not adequate to describe any of the phenomena during transition from wholly subsonic to subsonic-supersonic flow in a nozzle. For a one-dimensional theory, shock waves together with an otherwise perfect fluid are enough. From this report it can be concluded that for the corresponding two-dimensional problem a perfect fluid theory supplemented with shock waves is still not enough. For adequate check with experiment, a theory must be based upon a fluid with friction (at least in regions near the walls; in other regions friction would have no effect). Solutions with this imperfect fluid involve a prohibitive amount of labor with present computing techniques. *Technical Note No. 1003*, May, 1946.

Velocity Distribution on Wing Sections of Arbitrary Shape in Compressible Potential Flow. Part I: Symmetric Flows Obeying the Simplified Density - Speed Relation. Lipman Bers. As a first step toward the computation of the velocity distribution along a wing profile of arbitrary shape in a compressible fluid, the circulation-free flow around a symmetric profile is treated under the assumption of the simplified density-speed relation credited to Chaplygin, von Kármán, and Tsien. The velocity distribution problem is reduced to a nonlinear integral equation which is solved by a fairly rapidly convergent iteration method. Numerical examples are given. *Technical Note No. 1006*, April, 1946.

Clamped Long Rectangular Plate under Combined Axial Load and Normal Pressure. Ruth M. Woolley, Josephine N. Corrick, and Samuel Levy. A solution is presented for the buckling load and load carried after

buckling of a clamped rectangular plate having a width-length ratio of 1:4 under combined normal pressure and axial load. The calculations are carried out for two values of normal pressure and a range of axial loads considerably in excess of those required to buckle the plate.

The results indicate that normal pressure causes a smaller increase in the buckling load of plates with clamped edges than of plates with simply supported edges. They also indicate that neglecting the effect of lateral pressure on the sheet buckling load and on the load carried by the sheet after buckling is conservative design in the elastic range. *Technical Note No. 1047*, June, 1946.

Preliminary Investigation of the Loads Carried by Individual Bolts in Bolted Joints. Manford B. Tate and Samuel J. Rosenfeld. A general solution is presented for the determination of loads carried by individual bolts in symmetric butt joints. Expressions for bolt behavior are given by which the general solution may be readily adapted to the numerical calculation of bolt loading in joints made of any of several combinations of materials common to airplane construction, and an example is solved to illustrate the numerical procedure. All expressions are confined to the range of elastic action of joint components.

Tests were conducted in which the test specimens were made of 24S-T aluminum-alloy plates fastened by two or three $^1/_4$-in. alloy-steel bolts, with the bolts in a single line in line with the applied load. Test results are given in the form of curves showing bolt-load histories through the elastic and yield ranges to joint failure. Empirically based principles are proposed to define the practical upper limit of elastic action of a joint subject to static loading and to obtain curves representing bolt action above this limit for three-bolt joints. With empiric data, such curves combined with analytic equations provide a means for the prediction of bolt loads at any joint load. Bolt-deflection curves are also presented.

From the tests of three-bolt joints, agreement within about 10 per cent was found between theoretic and experimental bolt loads within the elastic range. Although the bolts carried markedly unequal loads in the elastic range (as indicated by theory), it was found for such joints (containing not more than three bolts in the line of stress) that a process of bolt-load equalization took place beyond the limit of elastic action which for practical purposes caused the bolts to be loaded equally at joint failure. Information is needed with respect to multirow joints, however, because in the elastic range the bolts in the first rows carry far greater loads than interior bolts, and joint failure may occur before complete equalization of bolt loads is realized. *Technical Note No. 1051*, May, 1946.

An Investigation of Additional Requirements for Satisfactory Elevator Control Characteristics. William H. Phillips. Tests of three airplanes have been conducted in an effort to develop elevators that would provide stick forces in steady turns within the limits required by the Army and Navy handling-qualities specifications over a large range of c.g. positions (about 10 per cent of the mean aerodynamic chord). In order to obtain the desired stick forces in steady turns, closely balanced elevators were used in conjunction with bobweights or with types of balance that gave the elevators a tendency to float against the relative wind. Although the desired stick forces in steady turns were obtained, the control characteristics were considered unsatisfactory by the pilots because of the lightness of the forces required in rapid pull-ups and because of the uncertainty of the control in rough air. These tests indicate that the desire to provide stick forces in steady turns within specified limits over a large c.g. range tends to conflict with the need for sufficiently heavy stick forces in maneuvers involving rapid stick movements. Several factors that may limit the degree of elevator balance permissible (and hence set a limit on the allowable reduction in variation of force per g with c.g. position) are discussed.

As a result of the tests, requirements have been added to the Army and Navy stability and control requirements for airplanes that the gradient of elevator control force per g in quick pull-ups shall never be less than in steady turning flight under the same conditions. Further research is needed to determine whether a more severe restriction is desirable and to investigate flight-test procedures for studying control characteristics in quick maneuvers. *Technical Note No. 1060*, June, 1946.

Consideration of Dynamic Loads on the Vertical Tail by the Theory of Flat Yawing Maneuvers. John Boshar and Philip Davis. Dynamic yawing effects on vertical-tail loads are considered by a theory of flat yawing maneuvers. A comparison is shown between computed loads and the loads measured in flight on a fighter airplane.

The dynamic effects were investigated on a large flying boat for both an abrupt rudder deflection and a sinusoidal rudder deflection. Only a moderate amount of control deflection was found to be necessary to attain the ultimate design load on the tail. In order to take into account dynamic effects in design, specifications of yawing maneuverability or control movement are needed. *Technical Note No. 1065*, June, 1946.

Comparison of Several Methods of Predicting the Pressure Loss at Altitude Across a Baffled Aircraft-Engine Cylinder. Joseph Neustein and Louis J. Schafer, Jr. Several methods of predicting the compressible-flow pressure loss across a baffled aircraft-engine cylinder were analytically related and were experimentally investigated on a typical air-cooled aircraft-engine cylinder. Tests with and without heat transfer covered a wide range of cooling-air flows and simulated altitudes from sea level to 40,000 ft.

Both the analysis and the test results showed that the method based on the density determined by the static pressure and the stagnation temperature at the baffle exit gave results comparable with those obtained from methods derived by one-dimensional flow theory. The method based on a characteristic Mach Number, although related analytically to one-dimensional flow theory, was found impractical in the present tests because of the difficulty encountered in defining the proper characteristic state of the cooling air.

Although the cylinder-baffle resistance coefficient determined by the density method was consistent for a wide range of heat-transfer values, a distinct difference was observed between the values with and without heat transfer that could not be explained by one-dimensional flow theory. Accurate predictions of altitude pressure loss can apparently be made by these methods, provided that they are based on the results of sea-level tests with heat transfer. *Technical Note No. 1067*, May, 1946.

Effects of Axial-Plane Curvature and Passage-Area Variation on Flow Capacity of Radial-Discharge Impeller with Conventional Inlet Buckets. William K. Ritter, Ambrose Ginsburg, and Alfred C. Redlitz. An experimental radial-discharge impeller was designed to have, by comparison with conventional impellers, a long radius of axial-plane curvature, a large axial depth, and a small inlet-blade root diameter. The impeller had conventional inlet-bucket bending and inlet and discharge diameters similar to an existing commercial impeller. This experimental impeller was tested as part of an investigation to improve the flow capacity of radial impellers. The performance effect of impeller-passage area was investigated by tests of a series of three impeller front-shroud profiles. The impeller passages of profile 1 had constant area along the mean flow path taken in an axial plane. Profiles 2 and 3 had uniformly converging areas along the mean flow path.

The best performance for the experimental impeller was obtained with impeller blade profile 1, but the advantage over profiles 2 and 3 was apparently diminishing with increasing impeller-tip speed. A comparison of specific flow capacity with that of a conventional radial-discharge impeller of approximately equal inlet and discharge diameters and with that of a mixed-flow impeller at an impeller-tip speed of 1,200 ft. per sec. showed the experimental impeller to have a specific capacity 47 per cent greater than the conventional radial-

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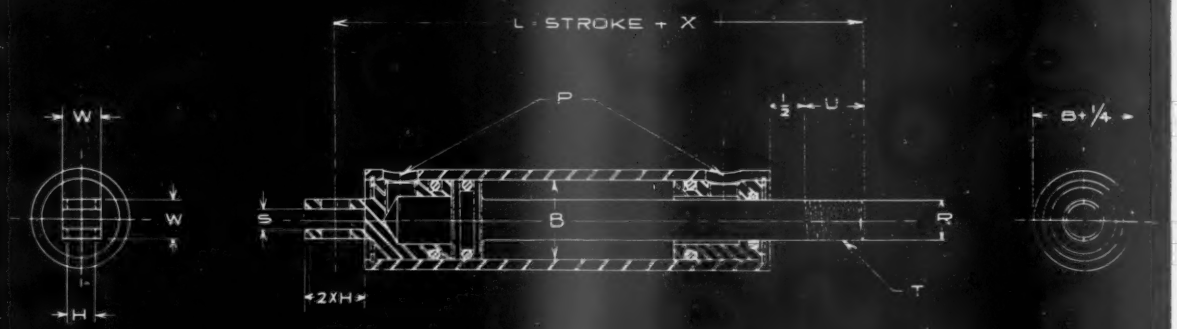

MODEL	BORE "B"	HOLE "H"	PORTS "P"	ROD "R"	SLOT "S"	THREAD "T"	LENGTH "U"	WIDTH "W"	X
3	¾	¼	⅛-27N.P.T.	¼	⅛	¼-28NF-3	9/16	5/16	4¼
4	1	⅜	⅛-27N.P.T.	⅜	¼	⅜-24NF-3	¾	½	4 11/16
5	1¼	⅜	¼-18N.P.T.	½	⅜	½-20NF-3	¾	⅜	5
6	1½	½	¼-18N.P.T.	¾	½	¾-16NF-3	1⅛	¾	5 9/16
7	1¾	½	⅜-18N.P.T.	¾	⅝	¾-16NF-3	1⅛	⅞	5 13/16
8	2	¾	½-14N.P.T.	⅞	¾	⅞-14NF-3	1 5/16	1	7⅛
10	2½	1	½-14N.P.T.	1⅛	1	1⅛-12N-3	1 11/16	1⅜	7⅞
12	3	1¼	¾-14N.P.T.	1¼	1¼	1¼-12N-3	1⅜	1⅝	8 13/16

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discharge impeller and 2 per cent greater than the mixed-flow impeller. Most of the increase in volume flow capacity of this impeller, as compared with the conventional radial-discharge impeller, may be attributed to the gradual change in direction of the impeller passage resulting from the rear shroud profile of large radius of curvature and the large axial depth. A small increase in volume flow capacity was due to a slightly larger impeller-inlet annular area. *Technical Note No. 1068*, May, 1946.

Effect of the NACA Injection Impeller on the Mixture Distribution of a Double-Row Radial Aircraft Engine. Frank E. Marble, William K. Ritter, and Mahlon A. Miller. The N.A.C.A. injection impeller was developed to improve the mixture distribution of aircraft engines by discharging the fuel from a centrifugal supercharger impeller, thus promoting a thorough mixing of fuel and charge air. Tests with a double-row radial aircraft engine indicated that for the normal range of engine power the N.A.C.A. injection impeller provided marked improvement in mixture distribution over the standard spray-bar injection system used in the same engine. The mixture distribution at cruising conditions was excellent; at 1,200, 1,500, and 1,700 b.hp., the differences between the fuel-air ratios of the richest and the leanest cylinders were reduced to approximately one-third their former values. The maximum cylinder temperatures were reduced about 30°F. and the temperature distribution was improved by approximately the degree expected from the improvement in mixture distribution. Because the mixture distribution of the engine tested improved slightly at engine powers exceeding 1,500 b.hp. and because the effectiveness of the particular impeller diminished slightly at high rates of fuel flow, the improvement in mixture distribution at rated power and rich mixtures was less than that for other conditions.

The difference between the fuel-air ratios of the richest and the leanest cylinders of the engine using the standard spray bar was so great that the fuel-air ratios of several cylinders were below the chemically correct mixture, whereas other cylinders were operating at rich mixtures. Consequently, enrichment to improve engine cooling actually increased some of the critical temperatures. The uniform mixture distribution provided by the injection impeller restored the normal response of cylinder temperatures to mixture enrichment.

The hazard of engine backfiring was reduced because the volume of combustible charge in the intake system was decreased and because excessively lean cylinders were eliminated through improvement in the mixture distribution. For the engine tested, no serious loss in supercharger pressure rise resulted from the injection of fuel near the impeller outlet instead of from the carburetor spray bar. The injection of fuel near the impeller outlet does, however, reduce the possibility of carburetor icing. The injection impeller furnishes a convenient means of adding water to the charge mixture for internal cooling. *Technical Note No. 1069*, May, 1946.

Effect of Brake Forming on the Strength of 24S-T Aluminum-Alloy Sheet. George J. Heimerl and Walter Woods. Tests were made to determine the effect of brake forming on the strength of 24S-T aluminum-alloy sheet that had been formed to an inside bend radius of three times the sheet thickness. The results for both directions of grain of the material showed that the compressive yield stresses were appreciably increased, the tensile yield stresses were moderately increased, the ultimate tensile stresses were only slightly increased, the elongations were considerably reduced, and the shapes of the tensile and compressive stress-strain curves were markedly changed. *Technical Note No. 1072*, May, 1946.

Tests of a Full-Scale Horizontal Tail Surface in the Langley 16-Foot High-Speed Tunnel. Carl F. Schueller, Peter F. Korycinski, and H. Kurt Strass. Tests to determine the aerodynamic characteristics of a full-scale semispan horizontal tail surface of a fighter-type airplane have been conducted in the Langley 16-ft. high-speed tunnel. The tests were carried to a maximum Mach Number of 0.7 except for model configurations, for which the maximum allowable loads were reached at lower speeds. The results presented show the effects of elevator nose shape, elevator trailing-edge angle, and trailing-edge strips on the aerodynamic characteristics of the model. Results are also given for a few measurements of the external and internal elevator pressures and the extent of laminar flow on the stabilizer.

Increasing the Mach Number from 0.2 to 0.7 resulted in a marked increase (-0.0015 to -0.0032) in the rate of change of hinge-moment coefficient with elevator deflection; a small increase (0.0025 to 0.0027) in the rate of change of hinge-moment coefficient with angle of attack; and an appreciable loss (0.51 to 0.34) in elevator effectiveness.

The incremental changes in elevator hinge-moment characteristics due to modifying the elevator nose contour were of about the same magnitude as would be predicted by the use of recently published methods. *Technical Note No. 1074*, May, 1946.

Effect of Compressibility on Section Characteristics of an Airfoil with a Round-Nose Slotted Frise Aileron. Arvo A. Luoma. Compressibility effects on the aerodynamic section characteristics of an airfoil with a round-nose slotted Frise aileron were investigated from pressure distributions obtained at various airfoil angles of attack and aileron angles, for Mach Numbers from 0.25 to approximately 0.76. The aileron tested represented a modification of a sharp-nose Frise aileron previously investigated by the N.A.C.A. The modification included an increased nose radius as well as an increased balance chord.

Modifying the nose of the aileron improved the section aileron effectiveness at large negative aileron deflections and slightly reduced the effectiveness at moderate aileron deflections. The wind-tunnel data indicated a reduction in stick force and an improvement in stick-force characteristics at high diving speeds; however, the tendency of the upgoing aileron toward excessive overbalance at these high speeds still existed. Section aileron loads were essentially unchanged by modifying the aileron nose. *Technical Note No. 1075*, May, 1946.

An Analysis of the Factors Affecting the State of Fuel and Air Mixtures. Mitchell Gilbert, John N. Howard, and Bruce L. Hicks. The factors important in determining the state and the rate of change of state of mixtures of liquid fuel, fuel vapor, and dry air are discussed with reference to basic physical variables such as pressures, temperatures, and amounts present of liquid fuel, fuel vapor, and air.

Data in the form of curves and tables are given to enable estimation of temperatures and other conditions required for complete or partial vaporization of various fuels. An estimate is made of the maximum and minimum time for evaporation of different sizes of fuel drops and the importance of knowledge of the factors affecting vaporization time is indicated from this estimate. *Technical Note No. 1078*, May, 1946.

Summary and Analysis of Data on Damping in Yaw and Pitch for a Number of Airplane Models. William E. Cotter, Jr. Damping data obtained from free-flight-tunnel tests of 13 models have been summarized, and these results have been analyzed and compared with calculated results. The contributions of the wing, flaps, fuselage, tail surfaces, and power to the damping in pitch and yaw were studied. For complete models fairly good agreement was obtained between experimental and calculated values for power-off, flaps-neutral conditions. Further research is needed on the effects of sidewash on the damping in yaw for power-on and/or flaps-down conditions. The damping provided by a wing without flaps was found to be small. Deflection of full-span flaps noticeably increased the damping in yaw. The contribution to damping of the fuselage was found to be negligible. The tail surfaces of conventional designs contributed 70 to 90 per cent of the damping in yaw and pitch. Power application increased damping both in yaw and in pitch. The damping of tailless designs was about one-third to one-tenth that of conventional designs. *Technical Note No. 1080*, May, 1946.

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The Chance Vought V-173, a full-sized, low-powered flying "model" of the Navy's new experimental fighter, the XF5U-1. This radical flying-wing design is stated to be capable of maintaining flight at speeds ranging from 40 to 425 m.p.h. With the addition of water injection, the range could be extended from 20 to 460 m.p.h. The XF5U-1 is powered by two Pratt & Whitney R-2000-2 engines which, through a transmission system, turn the propellers at approximately 1/5 the r.p.m. of the engine. In case of engine failure either engine can drive both propellers.

Navy Department

Fundamental Scientific Research Program. A folder contains an outline of the postwar program of scientific research sponsored by the Office of Research and Inventions. It explains the reasons for the work, how the program operates, and lists the principal fields of research in which work is planned. Among the classifications are studies of guided missiles, flight, and propulsion. *Office of Research and Inventions.*

British Information Services

Torsiograph Observations on a Merlin II Engine, Using a Serrated-Condenser Pick-Up, with Five Different Pitch Settings of the Propeller Blades. B. C. Carter and J. R. Forshaw. This report is based upon the first application of the torsiograph described in "Design and Development of a Torsiograph Having a Serrated Condenser Pick-Up Unit," *R. & M. No. 1982*, 1945, the observations being made in the course of development of the instrument. Subsequent applications have been to Merlin 61 and Sabre engines.

The torsiograph pick-up unit was fixed into the pinion-driving shaft of a Merlin II engine on a hangar test bed and records were obtained at various crankshaft speeds from 900 r.p.m. to 3,000 r.p.m., and with the following blade settings: 16.5°, 20.5°, 22.5°, 25.5°, and 29°, measured from the propeller disc at 42 in. from the shaft axis. The observed cyclical torque oscillations have been analyzed into harmonic components and the causes of the corresponding modes of vibration are examined in the report. To assist this examination, some vibrograph observations were made, and also a mathematical analysis which is given in an appendix.

There were three predominant modes of "torsion-bending" vibration, for which the blade-bending vibrations were fundamental flapping, first overtone flapping, and a combined fundamental edgewise and first overtone flapping; at 15° pitch angle, the respective frequencies were 3,150, 5,000, and 6,050 cycles per min. Owing to the proximity of the natural frequency of the system in the axial direction to the frequencies for fundamental and first-overtone torsion-bending modes, the axial-bending mode of vibration was strongly coupled with these torsion-bending modes. The torsional components of these complex coupled modes were recorded by the torsiograph and the frequencies were found to be 4,200 and 5,600 cycles per min. for 15° pitch; the magnitudes were comparable with those for the torsion-bending modes. It is probable that the coupling occurred between torsion-bending and rolling oscillation of the engine on its mounting, but this hypothesis was not supported by the vibrograph observations, whereas appropriate axial vibration was recorded by vibrograph.

The resonant frequencies for all modes of vibration decreased with increase of blade pitch except for the first-overtone-propeller torsion-bending mode, which was almost a fixed-root mode of vibration and only changed in frequency at the higher pitch angles, for which the frequency increased a little. The fall of resonant frequency with increase of pitch is inconsistent with the accepted torsion-bending theory assuming a rigidly held thrust race, and it is doubtful whether a full explanation can be found without further experiments in which changes are made in the rigidity of the engine mounting.

By plotting calculated deflection diagrams for the torsional system, it was found that the modes of vibration with an antinode in the shaft containing the torsiograph occurred at 19,000 cycles per min. and 34,000 cycles per min. As the torsiograph can give no indication of resonance at these frequencies, it is clear that for complete investigation of the torsional vibration it would be necessary to make observations with two torsiographs, thereby avoiding "blind spots" in the frequency range. Judging from the corresponding stresses in the crankshaft, the two-noded mode of crankshaft torsional vibration appears to be relatively unimportant, but it has been found that this mode of vibration may give rise to high stresses in the propeller blades. Throughout the records, a twenty-first engine order vibration of small magnitude was present, which was caused by tooth engagement, and a forty-second engine order vibration was present on some of the records. The conclusions reached in the present investigation are in certain respects somewhat tentative because they are based upon observations made at only two points in a highly complex vibrating system. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1983.* British Information Services, New York, $1.20.

Prediction of Undercarriage Reactions. G. Temple. The object of this report is to give a connected account of the methods that have been developed at the Royal Aircraft Establishment for the prediction of undercarriage loads under symmetric landing conditions; to extend these methods to deal with other landing maneuvers; and to formulate a simplified system of step-by-step computation of the loads.

The report is divided into three parts. Part I, "Basic Data and Preliminary Calculations," itemizes the basic information required, either in the form of design data or of experimental results. Part II, "Equations of Motion for Standard Landing Conditions," gives the fundamental equations for a tail-wheel or nose-wheel aircraft. Part III, "Step by Step Methods of Integration" describes the principle of the method of computation. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1927.* British Information Services, New York, $1.90.

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Howard Mingos, *Editor*

Contents: Air Power—Peace Power; Technical Progress in Aviation; The Army Air Forces in War and Peace; Naval Aviation in War and Peace; Air Transportation; Private and Non-Scheduled Flying; Aviation Education and Training; Airports and Airways; Federal Agencies in Aviation; American Aircraft—War and Postwar; Aircraft Power Plants; New Aviation Accessories.

The first part of the 28th annual edition of this aviation reference book reviews the contributions of air power to the winning of the late war, and shows how the technical advances attained during the war can be applied to peacetime aeronautical developments. The accomplishments of the Army Air Forces and of the naval aviation units are related, also with reference to the application of wartime inventions to commercial aviation.

Air transportation throughout the world is dealt with in paragraphs recalling the services performed by the air lines during the war, and giving figures concerning the expansion of their civil operations. Chapters outline the functions of the Government agencies that control aviation, and the progress made in training, in private flying, and the establishment of airports and other ground facilities.

The activities of each of the American manufacturers of aircraft and engines are listed, with figures revealing their war production and their postwar plans. A chapter about aircraft accessories is followed by extensive tabulated statistics concerning production and destruction of aircraft during the war, domestic air-transport operations, and other facts and figures. The directory section lists Government agencies, associations, companies, and individuals engaged in the many fields of aviation. Lanciar Publishers, Inc., New York, 1946; 702 pages, $6.00.

Understanding Microwaves

Victor J. Young

Contents: The Ultra High Frequency Concept; Stationary Charge and Its Field; Magnetostatics; Alternating Current and Lumped Constants; Transmission Lines; Poynting's Vector and Maxwell's Equations; Waveguides; Resonant Cavities; Antennas; Microwave Oscillators; Radar and Communication; Microwave Terms, Ideas, and Theorems.

The intention of the author is to provide, for the average reader having a fundamental knowledge of electricity, a basis for understanding microwave radio and radar. Its study will aid those who have not yet considered radio waves shorter than 10 cm., and should allow them to progress to the various advanced ideas. Mathematical explanations have been eliminated so far as possible. Because of this, and also because of the introductory nature of the first few chapters, it is intended that the book will be helpful both to engineers and to those interested in radio from the standpoint of service or operation. The author states that the only prerequisites that are necessary to an understanding of this work are an ordinary knowledge of the conventional uses of electricity and a willingness to think in terms of physical ideas and experiments.

As a secondary objective, the book endeavors to break down the psychologic bar to electromagnetic theory which is often experienced because of the mathematical manner in which that subject is usually introduced. The physical ideas of electromagnetic fields are greatly emphasized.

The author explains the fundamental problems encountered in the field of ultra-high-frequency research and production, and how they are solved, as well as the theories of electromagnetic and electrostatic fields, microwave generation, radiation, and reflections. Section II contains a comprehensive collection of definitions and terms used in radar and microwave communication work. The text is illustrated by many charts, diagrams, sketches, and photographs. John F. Rider Publisher, Inc., New York, 1946; 385 pages, $6.00.

From Balloon to Bomber

Wm. F. Burbidge

The author states that his aim is to tell in a general way the story of aeronautics and not to make a technical study of aeronautical progress. Each topic is discussed from its beginnings to the present in a separate chapter. The balloon, the parachute, the airship, and the art of gliding take up the first third of the book, followed by the development of the airplane up to 1914; then the war years and the foundation and development of the Royal Air Force up to the present. The 20 years of progress between wars are treated in terms of the notable flights and records of those years, with a separate chapter on the Schneider Trophy races. The book ends with brief discussions of the development of air transport, jet propulsion, and the war in the air recently ended. Selected flights and records are listed in appendix tables.

In such a brief review, omissions must be made. Among the topics that the American reader will have to find elsewhere are Lindbergh's New York-to-Paris flight, the contributions of Glenn H. Curtiss to naval aviation, the glider flights of J. J. Montgomery, and rotating wing aircraft. There is no evidence that the author is acquainted with publications that have thrown new light on the Langley "aerodrome" flights of 1914, the life of William Samuel Henson, and aeronautics in the American Civil War.

However, this is a readable short history, generally accurate, which should be useful as an introduction. It is written from the British point of view, and should be supplemented by other general histories and by specialized histories where a more complete picture is desired. John Crowther, Ltd., London, 1946; 238 pages, 13*s*. 6*d*.

Mathematical Theory of Elasticity

I. S. Sokolnikoff and R. D. Specht

The first three chapters of a book on the mathematical theory of elasticity contain a comprehensive treatment of the underlying theory of the mechanics of deformable media. Compactness is achieved by the use of tensor notation. In specific applications of the theory, where the economy of thought achieved by tensor symbolism is in some doubt, it is dropped in favor of the customary scalar notation. Chapter IV studies the extension, torsion, and flexure of homogeneous beams.

Chapter V contains a development of variational methods necessary for the treatment of problems of elas-

ticity. Several procedures for deducing approximate solutions of the boundary-value problems of mathematical physics are outlined and illustrated by their application to the torsion and flexure problems. Chapter V includes also a derivation of several energy and reciprocity theorems and a discussion of the Rayleigh-Ritz, Galerkin, and Trefftz methods of obtaining approximate solutions of the boundary-value problems, as well as a discussion of the method of finite differences. McGraw-Hill Book Company, Inc., New York, 1946; 373 pages, $4.50.

Designing with Magnesium

Application of magnesium to structural use in aircraft is stressed in a book about designing with that metal. A general discussion of the characteristics of the metal and its commercial alloys reviews the reasons for the important position that magnesium occupies among structural materials. Some of the other subjects discussed are weight saving with magnesium; choice of fabrication; stiffness and modulus of elasticity; hardness and resistance to wear; resistance to fatigue; dimensional changes in service; high- and low-temperature properties; machining; and structural design. Other properties of the metal are dealt with, as well as methods of fabrication.

The writer states that the proportional consumption of magnesium per aircraft has greatly increased within the past few years but that there is little doubt that magnesium is not used to the greatest possible extent even in the most advanced aircraft designs, chiefly because of lack of experience in its use. The relative amount of magnesium in aircraft design is, therefore, predicted as bound to increase, even when allowing for the fact that materials competitive with magnesium are also being continuously improved in their properties and reduced in cost. American Magnesium Corporation, Cleveland, 1945; 323 pages.

Book Notes

Airport Planning, by Charles Froesch and Walther Prokosch; John Wiley & Sons, Inc., New York, 1946; 250 pages, $7.00.

A book is offered for those who are interested in basic information regarding the planning and design of airports. Airport problems are analyzed from a fundamental and functional point of view. Some of the subjects discussed include the proper relationship of landing facilities to communities or regions which they are to serve; the integration of air-transportation facilities and the overall transportation problem; the characteristics of aircraft which affect the planning of airport facilities; the principal elements of landing facilities; and how to maintain a proper balance between the airfield and the buildings of an airport.

Aircraft Engines, Volume I, by A. W. Judge; Chapman & Hall, Ltd., London, 1945; 492 pages, 28*s*.

The first edition of this standard work was published in 1940. In the new edition of the first of two volumes, more than 100 pages have been added, including new material on carburetors and fuel systems, exhaust-driven turbines for superchargers, and air and water cooling. A new chapter on the internal-combustion turbine, including notes on jet propulsion, is added. B.M.W. and Junkers engines of recent design are included with other engines as examples of the different types.

In addition to further information concerning combustion and ignition, efficiencies and performances, new types of aircraft carburetors are described, and the section on the fuel-injection spark-ignition engine has been extended appreciably. The bibliography and the index have been expanded. Appendixes contain mathematical formulas for calculating cycle temperatures, supercharger performance, and tables of data regarding atmospheric conditions and radiator capabilities at varying altitudes.

Introduction to Aircraft Performance Calculations, by Capt. P. H. Sumner; Crosby Lockwood & Sons, Ltd., 1945; 83 pages, 7*s*. 6*d*.

Prepared to meet the need for a short, easy-to-understand text on the arithmetic of aircraft performance, this book explains basic procedure and supplies the necessary formulas. It begins with elementary mathematical determinations, followed by approximate formulas for general use, and then gives some calculations for an analytic investigation into the characteristics and performance of a particular airplane.

Air Power in War, by A. H. Narracott; Frederick Muller, Ltd., London, 1945; 168 pages, 8*s*. 6*d*.

Following a summary of the air-power theories of Douhet, Mitchell, and Trenchard, and those of Alexander de Seversky, J. M. Spaight, and Sir Oliver Stewart, the use of air power in the war is reviewed from 1939 to the dropping of atomic bombs on Japan. The author is an air correspondent of the London *Times* and brings a considerable knowledge of the subject to the writing of this book. His principal conclusions are that cooperation between air, land, and sea forces is essential, with decisions on the use of air power resting in the overall high command; air power is effective when it is capable of concentration, and to have this it must be flexible; mobility is essential in the case of short-range operational units. The need for a flourishing civil air transport that can be adapted to military use is strongly stated. The need for a strong aircraft industry and an adequate program of aeronautical research is implied but is not stated in the book.

Through the Stratosphere; the Human Factor in Aviation, by Maxine Davis; The Macmillan Company, New York, 1946; 253 pages, $2.75.

Material for this account of aviation medicine in World War II was gathered by the author in Alaska, France, Italy, India, China, and Africa, and from official sources in this country. The first part of the book is concerned with the testing methods used in selecting flying personnel and the development of the electrically heated flying suit, oxygen equipment, and the G-suit. The work of flight surgeons and equipment officers, preventive medicine, first aid in the air, vision, and parachute-jumping technique are followed by chapters on fear and operational fatigue. Rescue work, air evacuation, flight nurses, and rehabilitation are taken up in the last part of the book.

It is an excellent piece of reporting in which direct observation is successfully combined with data from official sources in a readable fashion. Aside from its value as a survey of the achievements of aviation medicine in World War II, the book is a review of many of the medical problems of high-altitude flight and their solutions as they stand at present.

British Seaplanes Triumph in the International Schneider Trophy Contests, 1913–1931, by Ellison Hawks; Real Photographs Co., Ltd., Southport, England, 1945; 80 pages, 7*s*. 6*d*.

The twelve contests held for the Schneider Trophy, which was permanently won by England in 1931, are described. The nine contests held from 1913 to 1926 take up the first quarter of the book. The remaining three-fourths is devoted to the final three races, biographic notes on the winning British pilots, details of the Supermarine S6.B, and the development of the Spitfire fighter and its engine.

The book would be more useful if it contained uniform descriptions of the competing airplanes and their engines instead of merely naming them, as it does in most cases. Since it is a compilation of data previously scattered in various sources, it is useful in its present form.

Dictionary of Aeronautical Terms, by Group Capt. H. Nelson; Sir Isaac Pitman & Sons, Ltd., London, 1946; 178 pages, 10*s*. 6*d*.

Definitions are given for about 2,400 British aeronautical terms and abbreviations. Terms in the related sciences which have aeronautical ap-

plications are included. A list of about 55 British words and their American equivalents is given in an appendix.

Aviation's Sketchbook of Aircraft Design Detail; McGraw-Hill Book Company, Inc., New York, 1946; 112 pages, $0.50.

The third edition of this publication contains sketches that present a well-rounded picture of the construction details of most types of aircraft engines, armament, and the structural parts of airplanes. Loose-leaf binding permits additional sketches to be added.

Rockets, by Robert H. Goddard; American Rocket Society, New York, 1946; various paging, $3.50.

Reprints of two technical reports by the late Dr. Robert H. Goddard, "A Method of Reaching Extreme Altitudes," and "Liquid-Propellant Rocket Development," are presented in this book. Originally printed by the Smithsonian Institution in 1919 and 1936, respectively, both reports were out of print.

The papers are reproduced by facsimile printing in order to present these historic publications to readers in exactly the way they first appeared.

The Yielding Phenomenon of Metals, by Georges Welter; The Kennedy Press Ltd., Manchester, England, 1946; 64 pages.

Because the kind of testing machine and its load-indicating device, as well as the rate of plastic deformation, seem to have great influence on the yielding of steel, these subjects were chosen as the main objects for this investigation. Besides a theoretic consideration, the various factors that have a pronounced influence on the yielding of metals, such as the kind of testing machine with its load-indicating device, as well as the rate of plastic deformation of the specimen, have been investigated. The transmission of the loads from the machine into the test specimen without harmful secondary effects was studied by means of three types of newly developed universal joints that allow loading the specimen axially. During these tests an artificial yielding effect was obtained by a relative displacement of the loading faces of the machines. Stress-strain diagrams were recorded under different loading conditions; diagrams showing a most characteristic difference between these two types of machines were obtained.

By means of a special device based on sliding friction between three plates screwed together, the dynamic behavior during yielding of metals in both types of testing machines was analyzed and interesting diagrams were recorded. The upper and lower yield points of mild steel were studied in function of the speed between about 400 lbs. and 20,000 lbs. per min. These tests show that the lower yield point is much more affected by high deformation speed than the upper yield point.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

The Development of Improved Means for Evaluating Effects of Torsional Vibration on Internal Combustion Engine Installations; Society of Automotive Engineers, Inc., New York, 1945; 578 pages, $10.

The report presents experimental and analytic methods used by the research departments of a number of leading Diesel engine manufacturers in investigating and applying means of controlling torsional vibrations.

The introduction sets forth the problems and conclusions. The major part of the book consists of analytic treatments and experimental methods used for measuring torsional vibration, methods for determining and estimating the significance of nominal torsional stresses, and means for reducing those stresses.

The characteristics of well-known and conventional torsional-vibration measuring equipment are discussed and compared, and unique types of torsiographs and torsiograph calibrators are described and illustrated. Attention is given to various shortcut methods that industry has found usable for calculating natural frequencies, and for rapidly determining those frequencies experimentally by the use of electrical and mechanical analogies. The distributed-mass method of frequency calculation is explained.

Attention also is given to the prime significance of the relationship between nominal and actual stresses. The workable experimental methods for determining stress concentration factors are examined. The experimental procedure for the fatigue testing of full-scale parts is explained. Diagrams and photographs of fatigue equipment are included. The design, construction, and application of representative types of torsional vibration dampers are discussed and an original treatment of the theory of the pendulum damper with complete design procedure is included.

The appendix contains, in addition to other material, suggested specifications for torsional-vibration equipment.

Meteorology with Marine Applications, by William L. Donn; McGraw-Hill Book Company, Inc., New York, 1946; 465 pages, $4.50.

Although intended primarily as a textbook for marine deck officers, this book is meant to serve also as a general introduction to the study of meteorology. It gives a groundwork in the observation and theory of the weather elements, and then presents an extended treatment of the hurricane, with attention to modern concepts of air masses and fronts as applied to weather interpretation. A feature of the book is a list of visual aids, that is, motion pictures and film strips, which is correlated with the material in the text.

Recommended Practices for Automotive Flash-Butt Welding (Tentative); American Welding Society, New York, 1946; 22 pages, $0.30.

The booklet contains standards prepared by a committee of the American Welding Society following a survey of flash butt welding as used by the automotive industry. The data were circulated throughout the country for review and are stated to represent the consensus of opinion of those connected with the flash butt welding process as used in automotive fabrication.

Flight and Engines, by G. V. Welbourne; Blackie & Son Limited, London, 1945; 202 pages, 8*s.* 6*d.*

The basic principles governing the flight of the airplane and the operation of its engine are set forth. The book has been written without constant reference to mathematics and is intended especially to meet the needs of the British Air Transport Command and the cadet in the early part of his training. Helpful questions are included at the end of each chapter.

Freedom From War, by Donald Bennett; Pilot Press, Ltd., London, 1945; 90 pages, 3*s.* 6*d.*

Air Vice Marshal Bennett's proposal for world peace provides for a supreme congress of nations and an international law force. Participation by each nation is proposed to be based on the ratio between its population and the world population, and between its average real income per capita to the average world income per capita.

Induction Heating, by H. B. Osborn, Jr., P. H. Brace, W. G. Johnson, J. W. Cable, and T. E. Eagen; American Society for Metals, Cleveland, 1946; 172 pages, $3.00.

The principles and theory of high-frequency heating are explained, and induction heating circuits and methods of frequency generation are described. Information is given about practical applications of the motor-generator type of induction heating using frequencies up to 10,000 cycles, and high-frequency induction heating using frequencies of 100,000 cycles and above. A comparison of induction heating with other methods of heat-treating is included.

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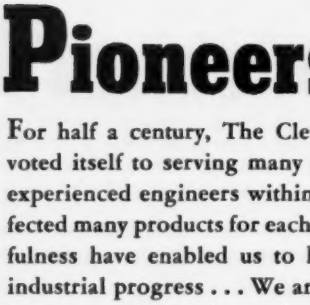

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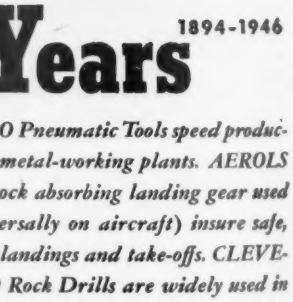

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Industry Publications

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Light-Plane Hydraulic Equipment

The Adel Main Landing Gear Strut No. 16045, built for light planes and now in use on the Globe Swift, is designed to take a limit load factor of 4.33 on a 1,750-lb. airplane. Fully extended, it has a length of only 25¾ in. between pivot and axle centers, thus allowing easier accessibility to the engine and the cabin. It will accommodate standard 6.00 by 6 aircraft tires mounted on spot-type brake-wheel drums. A complete hydraulic system for light planes, including tail wheel, shock struts, actuators, and the Dual Power Package and control system, has also been designed. Adel Precision Products Corporation, Burbank, Calif.

Report from Aerojet

An illustrated booklet reviews the development work that led to the adoption of jet-assistance devices for airplanes. It contains technical data and charts showing the effect of jet assistance as applied to the DC-3 transport and other airplanes. A section outlines the improvements that are indicated by the use of jet assistance in the relatively short flights involved in feeder-line and "skip-stop" transport service. The applications of jet devices for water-borne aircraft and gliders also are shown, and a prediction is made of future flight possibilities through the use of jet propulsion. Aerojet Engineering Corporation, Azusa, Calif.

Improved Fastenings for Cargo and Passenger Use

The first two of a group of new products, known as the Davis Cargo Tydown Gear, are a webbed strap equipped with hooks and buckles, and a new type of blanket, both of which are designed to secure airplane freight from shifting while the cargo craft climbs, turns, descends, or is buffeted by winds. Both the tie-down strap and the blanket are adaptations of equipment originally designed for use in U.S. Navy ambulance planes.

The new cargo tie-down strap can be varied from its greatest length to a mere 2 ft. without reducing its holding efficiency. One end of the strap is fitted with a permanently secured metal hook for attachment to wall or floor rings of the airplane, while the other end is free so that it may be inserted through a quick-adjusting, friction-locking buckle, and easily secured at any point along the strap's length.

In the loop formed by passage of the free end through the quick release buckle a second metal hook is provided which is free to ride on a rotating sleeve. Its design is such that it constitutes a block-and-tackle type arrangement whereby tension can be increased on the strap at any time. A feature of the buckle is a crossbar that automatically collapses at a predetermined pressure before sufficient tension to pull out the rings incorporated in the airplane structure can be applied to the strap. A separate metal link for cross latching one or more straps also is included.

The 6- by 8-ft. cargo blanket, designed for use in conjunction with the strap, is made of heavy duck and reinforced in two directions at intervals with webbed straps. At the end of each strap and wherever the straps cross, loops are provided for attachment of hooks. With this arrangement the blanket can be folded for use with smaller-sized articles and still be strapped from any point to the plane structure. In addition, through the use of "S" hooks, several blankets can be joined to form a continuous blanket strip without decreasing tensile strength.

A single-hand, quick-attach and release seat-belt buckle is intended to be convenient for air passengers to use, as only one hand is needed to release it, leaving the other free to hold purse, handbag, or parcels. By pressing a small button at the side of the clasp with the thumb, the safety latch releases and the belt is slipped free, all with a single motion of one hand.

The manufacturers have also developed a new plastic belt tip that is light in weight, noninflammable, and chemically unaffected by almost every type of cleaning agent. Air Associates, Incorporated, Teterboro, N.J.

Two-Way Radio Equipment Approved for the Ercoupe

The Super "52" two-way communication system, manufactured by Airadio, Incorporated, Stamford, Conn., has been approved for installation in the Ercoupe, according to an announcement by Engineering and Research Corporation, makers of the airplane, based on the findings of their test program.

The Airadio equipment provides two-way communication between control tower and plane, interphone between passengers and pilot, and radio range and standard broadcast reception. The equipment is distributed by Air Associates, Incorporated, Teterboro, N.J.

Tunable V.H.F. Receiver for Use on C.A.A. Omnidirectional Radio Ranges

The development of a new tunable V.H.F. receiver for operation on omnidirectional airways range systems is announced. The equipment is available for air-line flight tests on the New York-Chicago omnidirectional range in course of installation by the C.A.A. as the latest radio aid to navigation and control of aircraft.

Covering the range of 108–135 megacycles and including associated converter and indicating units, the A.R.C. receiver contains all circuits necessary for flight operations and experimental phase-comparison localizer installations. Aircraft Radio Corporation, Boonton, N.J.

Alcoa Aluminum and Its Alloys, 1946

The 1946 edition of a ring-bound handbook offers in concise form some of the fundamental information concerning the alloys of Alcoa aluminum. It incorporates data on many of the new alloys that have been developed in recent months and the special applications for which they are suited. The booklet also contains information about the forms in which these materials are available and the sizes that are in commercial production.

The first section gives general information about the physical and chemical properties of the alloys. The second section deals with wrought alloys, the third section with aluminum-alloy castings, and the fourth section with fabricating practices. In addition

to a general index, there is a special index to the many tables giving technical data and properties of the various alloys. Aluminum Company of America.

Welding and Brazing of Alcoa Aluminum

A ring-bound handbook contains current recommendations for joining Alcoa aluminum alloys. Specific instructions for the commercially important processes are given in the booklet, with particular reference to the needs of the practical welder. The important commercial welding methods are classified under two headings: (1) fusing welding, which includes the use of gas, atomic, carbon-arc and atomic hydrogen; and (2) electric resistance welding, which includes stock, seam, and flash butt welding methods. Newly developed joining methods for furnace, torch, and dip brazing of aluminum alloys also are included. Two pages of catalog illustrations portray the proper flame adjustment for torch welding and brazing of aluminum. Aluminum Company of America.

Aircraft Ignition Wiring Tester

Vibrotest Model 241 is an ignition-wiring tester of special design for aircraft service. It quickly, easily, and accurately indicates insulation resistance in ignition harness, without the labor of dismantling harness or engine cowling. Location of trouble in spark plugs, sleeves, wire, or insulation at any point of the engine, is a matter of moments. The device is intended to trace every possible ignition trouble, such as electrical leakage caused by moisture; leakage through cable insulation; leakage in distributor blocks and fingers; moisture or deposits on or around spark plugs or terminal sleeves; fouled or cracked spark plugs. The power source is self-contained.

The range of the instrument is from 0 to 2,000 megohms at 1,000 volts. Special scale distribution puts the 150-megohm point about one-third up the scale. The part of the scale arc below the 150-megohm point is colored red. The remainder of the scale arc is green. Correct indication of the trouble is therefore instantly at sight. Special 12-ft. leads with quickly applicable terminals are provided. Leads are housed in the case cover, so they can be left permanently connected with the meter. Associated Research, Inc., Chicago.

Beechcraft Bonanza—Personal Airplane

Designed and built for the utility of its owners, a new type four-place, all-metal, high-performance, low-wing, cantilever monoplane with fully retractable tricycle landing gear, solid cabin top, and full equipment as standard, will carry the trade-name Beechcraft Bonanza. Cruising at 175 m.p.h., its range is 750 miles, with a pay load of 780 lbs. It is equipped for both day and night instrument flight. Normal capacity includes four persons of 170 lbs. each and 100 lbs. of baggage. The two baggage compartments have a total content of $16^1/_2$ cu.ft.

A prominent feature of the Bonanza is the Vee, or butterfly tail. It is stated that tests have proved the V-tail to be superior to the standard empennage from the standpoint of aerodynamic drag, stability, lightness, cost, and improvement of the spare-parts situation. The control of the airplane is conventional, by the use of elevator and rudder controls. The Continental six-cylinder engine, developing 165 hp. at 2,050 r.p.m., is equipped with a pressure carburetor and stainless-steel mufflers and exhaust stacks. The mufflers serve as heaters for the cabin and the exhaust stacks are so designed that they assist the cooling of the engine by their jet action at the edge of the cowl flaps. The Beech electrically controlled variable-pitch propeller has a diameter of 7 ft. 4 in. The normal take-off run is 425 ft., the rate of climb is 950 ft. per min., service ceiling is 18,000 ft., and landing speed is 45 m.p.h. Among other specifications are gross weight, 2,550 lbs.; wing area, 177.6 sq.ft.; wing loading at gross weight, 14.35 lbs. per sq.ft.; wing span, 32 ft. 10 in.; fuel capacity, 40 gal. Beech Aircraft Corporation.

NOTICE

This is directed toward meeting two men, each one being a potentially top man in his respective field. You may be acquainted with one or both of these persons and will do both them and society in general a real service by calling this notice to their attention.

Mr. "A" is an Aeronautical Engineer with an exceptional background in aerodynamics. He likewise has been actively associated with practical design problems involving controls, maneuverability, and range studies. His interest is that of a scientific type of engineer who can be versatile either in a research program or a practical application of design principles. In analyzing proposals, he could command respect from any major aircraft manufacturer.

Mr. "B" is a sound Metallurgist whose background is such that he is perfectly at home with either ferrous or non-ferrous alloys. He could double in ceramics if the need arose. He will be more of the laboratory research type of physicist than a trouble shooter for production problems. Again, in this field he is widely known as a leader and is listened to with respect by leading metallurgists. He has been associated with either engine manufacturers or aircraft manufacturers and is currently well read on the problems facing engine manufacturers today.

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It is suggested that principals communicate either directly, or through the Institute officers if they wish, so that a proper meeting can be arranged. Communications should be addressed to:

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Boeing Stratocruiser Rudder Controls

Details of the rudder-control system of the new Boeing Stratocruiser have been announced by the manufacturer. Allowing greater ease of control through a power boost system, an automatic transfer of control to spring tab control in case of hydraulic failure, the new rudder retains pilot "feel" without putting undue loads on the flight crew.

In designing the tail surfaces, Boeing engineers had as their objectives easy pilot control in all conditions of flight, including sudden failure of one or more engines at critical low speeds, and sufficient control under landing conditions of rough air, poor visibility, or high cross winds.

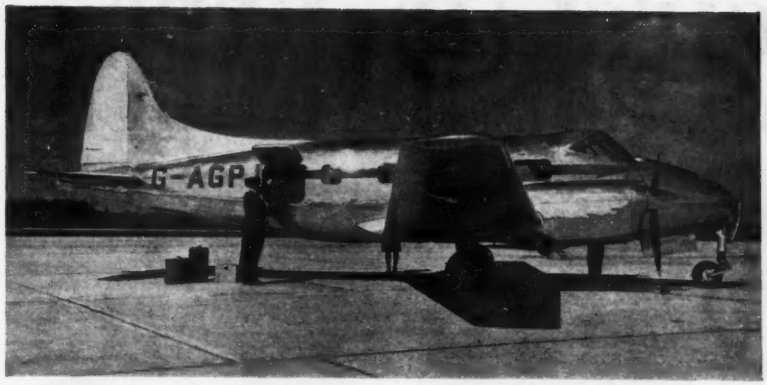
The actual rudder control of the Stratocruiser consists of a cable system from the pilot's foot pedals to a quadrant in the body just above the horizontal tail. Attached to this quadrant is a spring system, providing "feel" and trimming power, and also a torque tube leading up into the vertical fin. The top of the torque tube is attached to a lever system controlling the metering valve when the boost is operative, and controlling the spring tab after boost failure. An important safety feature is provided in that failure of any spring in the system will not result in any inadvertent control movement.

Hydraulic power is utilized from two engine-driven pumps, which also supply other hydraulic needs of the airplane. To overcome the customary lag between rudder-pedal action and movement of the rudder itself, an accumulator is installed in the tail of the airplane near the boost control valve. Pressure to operate the boost is thus tapped directly from the accumulator, and not from the oil-pressure lines. The boost is capable of moving the rudder 20° per sec., with virtually no lag. Boeing Aircraft Company.

Research and Development at the Jet Propulsion Laboratory, GALCIT

A 42-page report on the research and development activities at the California Institute of Technology Jet Propulsion Laboratory includes the following principal topics: Historical Sketch of Jet Propulsion Laboratory, Guggenheim Aeronautical Laboratory of the California Institute of Technology; Jato (Jet-Assisted Take-Off for Aircraft); Jet Propulsion under Water; and the California Institute of Technology's Ordnance Project (ORDCIT).

The sections contain detailed accounts of the work undertaken under the particular project, naming the scientists and others who participated, and describing the equipment used. Figures showing the results accomplished are given. The work was performed with the cooperation of the A.A.F. Air Matériel Command and the A.S.F. Ordnance Department. California Institute of Technology.



The de Havilland Dove.

Private Plane Features Comfort

The Dansaire Coupe is a plane designed to embody the comfort and safety of a well-built automobile and the speed of an airplane. It is featured by a large front seat that will accommodate three adults with adequate legroom and headroom. The cabin permits a vision range of over 300° in the air and 360° on the ground. The instruments are centered on the panel.

Design features include a double-tapered wing, a riveted aluminum-alloy tubular fuselage structure, and three-longeron fuselage layout. The rudder pedals come up through floor boards as in an automobile and are adjustable. The landing gear is of the cantilever type stabilized by a torque shaft across the fuselage. The flaps, ailerons, elevators, and rudder are built of straight, untapered sections, permitting right-and-left-hand units to be interchangeable. Other features include a soundproofed cabin, rubber fuel tank, hydraulic brakes, cabin heater, and radio. Dansaire Corporation, Dansville, N.Y.

The de Havilland Dove

Further details have been made available about the de Havilland Dove, eight-place transport aircraft. The air frame is entirely of metal. Stress-bearing skins are made of artificially aged aluminum-alloy sheet, which gives good buckle resistance and high strength. This is further enhanced by the method devised for attaching panel stiffeners. They are cemented by a plastic bond under heat and pressure, to produce a continuous joint of great shear strength and of a high perpendicular strength. Joints are never subjected to direct normal load, however. Protective treatment is applied inside all skins, and the outside surface is normally buffed bright.

The fuselage is built in three main units which are then permanently riveted together. These units are further subdivided for manufacturing purposes. The fuselage is attached to the wings at three points on each side and it embodies the center-section spar. The three main units are nose, cabin, and rear fuselage, and the nose and rear fuselage streamline the parallel-sided cabin unit, which is oval in cross section. The shape of the rear fuselage is a truncated oval cone. Bulkheads are located at the nose, at the tail, and at or near the joints between the three main units.

The wing structure, of the stressed-skin type, may be described as a tapering tube of irregular cross section, such as is produced by mutating the airfoil section at nose and tail. In other words, the front and rear secondary spars, together with the top and bottom skins, make the tube. The main spar web roughly divides the tube transversely into two cells. Chordwise ribs at regular intervals along the spar control the wing section. When completed this is an indivisible unit, except for access doors, fairings, and the like. The main spar is an I-section beam, the web being made of aluminum-alloy sheet and the booms of extrusions. The web is stiffened between ribs. Skins and stiffeners are of aluminum-alloy sheet and bonded by the Redux process. Main seams between skin panels are riveted. The fin has two spars, of which the front is swept-back and the rear is vertical. They are pressings of aluminum-alloy sheet and they carry the attachment fittings at the base. Pressed ribs give form to the sections in front of and between the spars and they are riveted to the skin. The rear spar mounts two rudder hinges.

The engines are two de Havilland Gipsy Queen 71, geared and supercharged, with direct fuel injection. De Havilland Hydromatic constant-speeding, feathering, and braking propellers are fitted. The engine complete with propeller, mounting frames, fire walls, oil tank, and cooler, all accessories connected to the fire walls, and with cowlings and spinner fitted, is a quickly interchangeable unit. It is attached to the wing by four bolts, and requires only the service connections, at the fire walls, to be made to complete an installation.

Important specifications are as follows: Pay load, 1,868 lbs.; total weight, 8,500 lbs.; maximum level speed, 222 m.p.h. at 5,800 ft.; recommended continuous cruising speed, 155

SINCLAIR KEEPS PACE...

Scale model of Sinclair Oil Corporation's new petroleum research and development laboratories planned for Harvey, Illinois. Studying the model (l. to r.) E. W. Isom V. P. Chg. of Research and Development, Sinclair Refining Company; Howard Jehu, Harvey Association of Commerce; Arthur E. Turngren, Mayor, and Sheldon Clark, Chairman, Executive Committee, Sinclair Oil Corporation.

with MODERN AVIATION PROGRESS

INCREASED facilities for research into all uses of petroleum and its products will be provided in Sinclair Oil Corporation's elaborate new research laboratory planned for Harvey, Illinois.

In this most modern of laboratories, recognized experts in petroleum technology will further the development of new and improved aviation fuels and lubricants to keep pace with the rapid expansion of present-day flying.

For over 15 years, Sinclair has pioneered in the development and manufacture of high quality aircraft engine oils and other aircraft lubricants. With the opening of the new research center, Sinclair will be in an even better position to cooperate in and promote the advancement of aviation in all its fields.

SINCLAIR AVIATION OILS

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m.p.h.; fuel consumption at recommended cruising speed, 22 gal. per hour; rate of climb at sea level, 750 ft. per min.; service ceiling, 18,500 ft.; take-off run under specified conditions, 770 yards; landing run, 750 yards; rate of climb at sea level on one engine using take-off power with opposite propeller feathered, 230 ft. per min. The de Havilland Aircraft Company, Ltd.

Expanded Service-and-Parts Program

An expanded spare parts-and-service program designed to meet requirements of a greatly increased fleet of Douglas commercial transports has been inaugurated by the Douglas Aircraft Company, Inc. It is estimated that 900 DC-3 and 225 DC-4 type airplanes will be in domestic service by the end of 1946, compared with 300 DC-3's operated by U.S. air lines before the war. The percentage of increase in foreign operations is even greater.

Regarding spare parts, the plans include retention of DC-3, C-47, and C-54 type production tooling for the manufacture of spares; addition of C-47 and C-54 parts to the present DC-3 parts inventory; manufacture and supply on special order of parts not listed in stock; and operation, under an agency agreement with the War Assets Administration, of a W.A.A. warehouse to handle inspection, modernization, stocking, and sales of Douglas C-47 and C-54 war-surplus parts.

Although the list is not complete, more than 35 carloads of surplus parts have been assembled by Douglas for sale under its agency agreement with W.A.A. It is stated that all parts ordered through Douglas, whether from new stocks or from W.A.A. supplies, will bear a manufacturer's warranty. No such warranty will be given for parts not obtained from the Douglas company or its agents.

To back up this new parts policy, the Douglas company is inaugurating a broad program of service activities, including extensive field-service representation, service centers, service publications, technical service, and service-analysis work. Douglas Aircraft Company, Inc.

Fuel-Injector for Light-Plane Engines

The Ex-Cell-O gasoline-injection system is designed especially for use on small aircraft engines instead of a carburetor, to meter mechanically the correct amount of fuel to each engine cylinder. It is reported that the new system provides a positive control over the fuel-air mixture, which results in better combustion and reduced fuel consumption, as well as improved engine performance and longer engine life.

The system consists of only four essential parts: (1) an injection pump, (2) an air throttle and linkage, (3) the discharge lines, and (4) the atomizing nozzle. The metering valve in the injection pump is linked to the air throttle lever on the air-intake manifold. Both are calibrated to provide the exact fuel air-ratio required for optimum engine performance and both operate in response to the throttle control lever. Thus, by simply moving the throttle control lever, a given amount of fuel is metered by the fuel-control valve to mix perfectly with the amount of air admitted by the air-intake throttle.

From the metering valve, fuel flows through a feed duct to the pumping and distributing plunger. The plunger, driven through gears at one-half crankshaft speed on a four-cycle engine, operates in a steel sleeve and is supported on a roller that rests against a cam face on the upper side of the gear. The number of lobes or lifts on the cam corresponds to the number of engine cylinders and produces a plunger stroke of approximately 0.050 in.

First applied to four-cylinder engines commonly used in small personal planes, the system is now being made for both four- and six-cylinder engines developing up to 250 hp. Ex-Cell-O Corporation, Detroit.

New Landing Gear Demonstrated

Announcement is made of the first flight of the Fairchild PT-19 with a cross-wind landing-gear installation that Fairchild Aircraft is developing along with a number of airplane manufacturers under contract with the C.A.A. The landing gear consists of castered wheels that allow the plane to come in obliquely and approach the runway at an angle that in normal flying increases the chances for ground looping. Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation.

Dual Remote-Control Automatic Radio Compass

The Fairchild AN/ARN-6 dual remote-control automatic radio direction finder for aircraft is said to differ greatly in size and design from previous automatic models, making it a practical navigational instrument. It is designed for four-band operation, to cover all normal broadcast transmissions, including those of European and Asiatic stations and marine beacons in the range of 100–1,750 kc., and is sufficiently light in weight (60 lbs.) to be carried in the smaller types of planes. The new band is 100–200 kc., and the other three bands are 200–410, 410–850, and 850–1,750 kc. In addition to providing wide navigational aid, the new low-frequency band reduces difficulty from night and mountain effects.

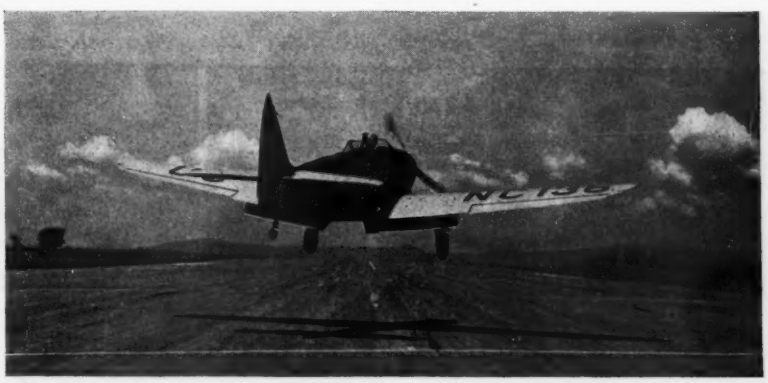
Components of the new unit are improved in performance through hermetic sealing. Its iron core loop, transformers, and phasing vibrator are sealed in atmospheres of dry nitrogen. Since requirements in global navigation are varied and severe, especially where high-altitude flying is necessary, the model is designed to withstand high-altitude effects, tropical deterioration, and high humidity, which change electrical characteristics. Fairchild Camera & Instrument Corporation.

Firestone Aircraft Tires and Accessories

A 33-page catalog describes and illustrates the Firestone line of aviation supplies for private-plane owners. The features of Firestone landing-wheel and tail-wheel tires are outlined and the available sizes are listed. Particulars are given about a steerable tail-wheel unit. Information and data are supplied about regular and adjustable-pitch propellers, aircraft radio equipment, finishes, batteries, tools, brakes, and many other accessories. The Firestone Tire & Rubber Company.

Greer Hydraulic Test Machine for Aircraft Hydraulic Systems

A portable machine for testing hydraulic systems of aircraft is described in a 4-page illustrated folder which contains detailed specifications, photographs, and drawings of the manufacturer's Model PG3-8 portable machine. Other portable and shop models of hydraulic testing equipment also are illustrated. Greer Hydraulics, Inc., Brooklyn.



Coming in at a sharp angle over the runway, the Fairchild PT-19 demonstrates the new cross-wind landing-gear installation under development by the C.A.A. The castered wheels permit the airplane to remain head-into the wind while landing on a runway not parallel to the wind direction.

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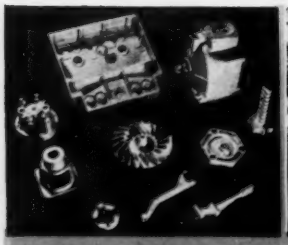

Die casting magnesium is an accepted method of producing lightweight parts with good surfaces and close dimensional tolerances.

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Ideal Machinery Products

Descriptions and illustrations of a wide variety of pneumatic and mechanical tools and accessories are contained in a booklet of 24 pages. In addition to photographs demonstrating the equipment in use, sketches show the interior construction. Tabulated specifications are given for the various tools, devices, and accessories for use with them. Ideal Industries, Inc., Sycamore, Ill.

Jessop-Saville Special Alloy and Tool Steels

For use pending completion of more comprehensive publications, a condensed catalog of special alloy and tool steels has been prepared by the manufacturers. The introductory chapter reviews the important points in the heat-treatment of such steels, and another chapter outlines the available qualities of carbon tool steels. These are followed by extensive tables giving the brand designations, compositions, heat-treatments, properties, salient features, and typical uses of a wide variety of carbon and alloy tool steels, die and mold steels, hot-work steels, and steels for special purposes, such as construction, corrosion resistance, heat resistance, and the manufacture of valves and magnets. A buyer's guide gives an alphabetical listing of typical applications for these various grades of materials, with reference to the brand designation and the page on which data are given. William Jessop and Sons, Ltd., and J. S. Saville Company, Ltd., Sheffield, England.

Jessop Stainless-Steel Welding Electrodes

Information about the selection of Jessop stainless-steel electrodes and their application to the arc-welding of stainless steels is contained in a 6-page booklet. The data enable the reader to select the correct electrode for the type of stainless steel to be welded. The current range is supplied for each type and diameter of rod. Jessop Steel Company, Washington, Pa.

Automatic Altimeter Setting

A remote-control radio device has been developed by the Kollsman Instrument Division of the Square D Company to aid air-traffic control and instrument-flying efficiency. The development incorporates a sensitive altimeter instrument that automatically corrects itself for barometric pressure changes as a plane flies within the range of special radio transmitters located at ground stations in mountainous regions, at airports, and other strategic spots. By the use of the Automatic Altimeter Setting instrument, potentially dangerous sources of error in the use of the conventional altimeter are eliminated and the work load on pilots, control-tower operators, and other operating personnel is reduced.

The compact, lightweight radio transmitters required for Automatic Altimeter Setting are actuated by a ground altimeter, are self-operative, and can be easily combined with existing radio-range stations. An automatic cutout device prevents confusion when an airplane is flying within the signalling range of two ground stations. The device automatically cuts out the weaker signal.

In the new Kollsman device a ground altimeter sends out its own altimeter setting continuously in the form of a coded radio signal. The airplane's altimeter receives the signal, automatically decodes it, and sets itself in accordance with it. Engineers state that the Automatic Altimeter Setting would eliminate one further aviation hazard which is at present difficult to deal with: the tendency of an altimeter to give incorrect readings when air temperatures aloft are unusually high or low, compared to the so-called "standard conditions." By placing an Automatic Altimeter Setting ground station upon mountain tops along the airways, erroneous readings caused by their radical deviation from normal temperature gradients can be eliminated.

An interesting detail of the new system is the manner in which the setting of the ground altimeter is coded for automatic radio transmission to the airplane. A four-digit figure must be expressed by a radio signal in such a manner that the air-borne altimeter can "read" and "understand" it and set itself accordingly. One method tentatively selected is to send over the radio an audible sound of definite frequency, in other words a musical note of a definite pitch. For example, a high C would mean an altimeter setting of 28.60. A low bass might mean an altimeter setting of 31.10. The airplane's altimeter contains a frequency analyzer that measures precisely the pitch of the incoming signal and then causes the altimeter to set itself accordingly. Kollsman Instrument Division of Square D Company.

Lockheed Saturn Transport

The Lockheed Saturn, designed to bring air travel to small towns now served only by surface carriers, incorporates three major advances developed during the war years—extra power gained from the jet thrust of engine-exhaust gases, a laminar-flow wing, and the new lightweight aluminum alloy developed for the pursuit fighters. The Saturn is distinguished by its high wing, providing unobstructed flight vision for all passengers, its unusually high rudder, and its low-slung fuselage, reached from the ground by a step of only 34 in. It has a wing span of 74 ft., overall length of 51 ft. 6 in., and height of 19 ft. 10 in. The plane is designed to carry 14 passengers or 3,000 lbs. of cargo, or any intermediate combination of the two. A quickly movable cabin bulkhead between the passenger and cargo compartments permits operators to carry people or packages in the proportion desired on any given flight.

The Saturn is powered by two engines, these being either the 800-hp., 7-cylinder Wright Cyclone or the 600-hp., 9-cylinder Continental, at the option of the purchaser. Two-bladed, paddle-type propellers made by the Aeroproducts Division of General Motors Corporation are used. Top speed of the airplane is more than 250 m.p.h. With 60 per cent power it cruises at more than 200 m.p.h. at normal altitudes. It takes off in 1,500 ft. At top gross weight of 16,000 lbs. it climbs 1,325 ft. per min. With one engine inoperative it can climb to 15,000 ft. Although designed primarily for efficiency on shorter regional flights, it has a maximum range of nearly 2,000 miles.

A feature of the design is accessibility for rapid ground service and loading and unloading. The entire hinged nose section can be swung back, affording access to all controls and the instrument panel from the ground. Normal inspection does not require removal of any interior trim. Such items as the main landing gear, landing-gear doors, power-plant units, engine cowlings, elevators and tabs, and wing flap assemblies are interchangeable from right to left or from plane to plane. This reduces the need for maintaining expensive inventories of duplicate spare parts and assemblies, and adds to the simplicity of Saturn maintenance. Lockheed Aircraft Corporation.

Research Plane Designed to Measure Flight Functions

The Minneapolis-Honeywell Regulator Company's "flying laboratory" airplane is equipped with electronic instruments designed to measure and record more than 1,000 different functions of flight. A converted C-47, it contains more than 20 miles of special electrical wiring that will enable flight engineers to connect any part of the plane or its engines to measuring devices and study reactions to various automatic control systems under test.

The new test airplane, which is equipped with twelve seats and two couches in the passenger compartment, also includes a special instrument room that replaces the baggage compartment of the conventional DC-3. Equipment for the plane includes: (1) More than $10,000 worth of special instrumentation, including a Honeywell electronic flight recorder capable of measuring and recording 144 different functions of flight every 3½ min.; a specially developed recorder to chart air speed, altitude, control positions, power conditions, direction, and similar information simultaneously, and more than 100 standard remote-indicating instruments. (2) A number of "extra" inverters and generators developing eight times the normal electrical power of a commercial airplane, including 400-cycle a.c. power for special instrumentation. (3) Four junction boxes in the instrument room containing more than 1,000 terminals. These are connected to vir-

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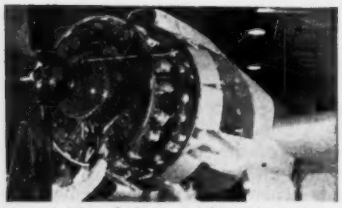

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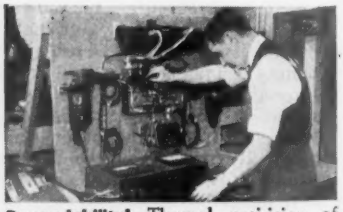

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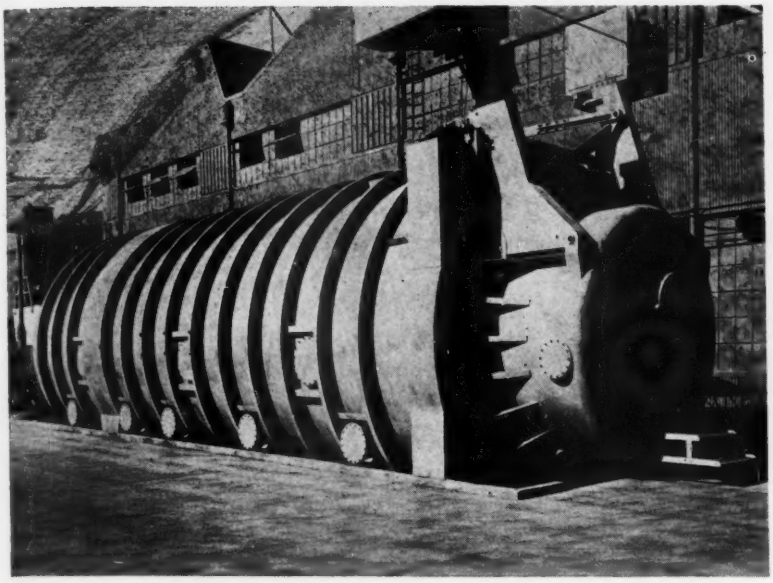


North American Aviation's new refrigerated altitude chamber. The chamber is closed by a 21-ton, counterbalanced door. The 12-ft. door can act as an auxiliary altitude chamber or as an air lock.

tually all parts of the airplane, including every cylinder, wing, control surface, and engine air-supply duct. (4) A dual radio compass that can be tuned to two different radio stations at the same time to locate accurately the airplane's position through triangulation. (5) Automatic blind-landing equipment designed to guide the plane to a landing without manual operation of the flight controls. (6) Electronic fuel-gage system providing accuracy within 2 per cent at all times regardless of temperature, altitude, or attitude of the airplane. (7) Three V.H.F. radio transmission channels; two standard command transmitters, one 75-watt transmitter, three standard aircraft receivers; three V.H.F. receivers, and two special receivers tuned to localizer and glide-path beams for blind landing. (8) Polyethylene-covered antenna to reduce radio static caused by rain and snow. This covering was developed by the Navy Department's ice-research group and is not yet available for commercial aviation. (9) An automatic electronic cowl-flap control to maintain engine temperatures at the desired setting. (10) Fluorescent lighting in the cabin concealed in the overhead ventilators to provide even, bright light throughout the passenger compartment. (11) More than 100 temperature pickups to measure temperatures in various locations of the cabin, wings, engines, etc. (12) Approximately 105,600 ft. of special wiring. Minneapolis-Honeywell Regulator Company.

Ternalloy Aluminum Alloys

Aluminum-magnesium-zinc alloys possessing high elastic properties are described in an illustrated bulletin. The text, charts, and illustrations give information concerning aging characteristics, mechanical and physical properties, and chemical composition of these materials. The bulletin is intended to enable foundry men and designers to become acquainted with the advantages of the material and to evaluate them for use. The National Smelting Company, Cleveland.

Refrigerated Altitude Chamber

A loose-leaf booklet describes a new refrigerated altitude chamber built by North American Aviation, Inc., for the purpose of carrying out aircraft research and development work. Inside the 75-ton steel chamber almost any climatic flying condition can be created. Temperatures from +200°F. to −100°F. and air densities from sea level to 60,000 ft. can be produced in the chamber to study problems of flying at different altitude ranges. Types of tests that will be conducted in the chamber are outlined. The construction of the chamber is illustrated and described. North American Aviation, Inc.

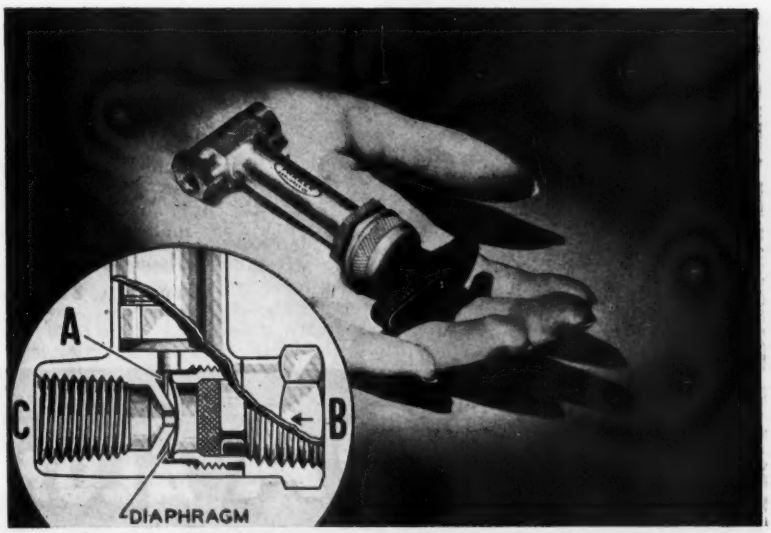
The Di-Acro System of Die-Less Duplicating

Basic principles and details of the Di-Acro system of duplicating parts without dies are set forth in a 40-page pamphlet. How parts having a wide variety of intricate shapes and outlines can be duplicated in different metals and materials is described. It is explained that the system is useful in experimental research laboratories, testrooms, and engineering departments, for developing and building experimental models, testing the stresses in materials, and determining processes of manufacture. The various duplicating machines and the methods of using them are described and illustrated. O'Neil-Irwin Manufacturing Company, Minneapolis.

Light-Plane Engine Primer

Because of a new and simplified check-valve design, the Parker Motarouser is reported to be considerably lighter, smaller, and less expensive than conventional models of equal capacity. The positive action of the new check valve also eliminates the necessity for both the plug cock shutoff valve and the vacuum check valve formerly required.

A simple rubber diaphragm check is used in place of the more complicated double spring-loaded ball construction. The diaphragm flexes upon plunger actuation to perform both intake and injection in the cycle of operation. The action of the simple diaphragm eliminates the possibility of engine



Parker Appliance Company's new "Motarouser."

Alcoa Aluminum ... AND A

BALMY DAY IN JUNE, 7 MILES UP

First, these facts: Ram temperatures created by air impact at 500 m.p.h., raise cabin temperatures about 40 degrees. Cabin supercharging accounts for a further rise. Sun's rays and other factors add more heat. Total, around 150 degrees. To cool cabins, giant airliners are using this midget air-expansion refrigeration turbine. A veritable "Tornado in a Teapot", this turbine is capable of effecting a 140° temperature drop at seven pounds air flow per minute. Machined from Alcoa Aluminum, it spins at 100,000 r.p.m., creating air velocities in the supersonic range.

Built by AiResearch Manufacturing Co., Los Angeles, this midget refrigeration turbine for aircraft air conditioning weighs only 3 pounds.

Alcoa Aluminum's high strength withstands the strains of these terrific rotor speeds. And, as for lightness, this turbine weighs only one-fiftieth as much as a conventional refrigeration system of similar capacity.

What's on your design board today? Shouldn't it be made of Alcoa Aluminum? For help, call your nearby Alcoa sales office. Or write ALUMINUM COMPANY OF AMERICA, 2142 Gulf Building, Pittsburgh 19, Penna.

ALCOA FIRST IN **ALUMINUM**

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vacuum sucking raw gasoline into the cylinders with resultant choked engine and scored cylinders, if the primer should accidentally have been left in the "on" position. A strainer of 60-mesh screen has been included on the inlet side of the primer to eliminate foreign matter and particles that might clog the engine jets if allowed to pass through the system. The Parker Appliance Company, Cleveland.

Anti-Icing and Anti-Fogging Coated Glass

A recent development by the Pittsburgh Plate Glass Company involves the use of a transparent, electrically conductive coating on glass whereby windshield deicing and defogging can be efficiently and economically realized by the application of electrical energy.

The material, identified by the trademark NESA, is a transparent, durable, electrically conductive coating. When applied to a glass panel its properties make it possible to heat the entire area of the panel by the uniform flow of electrical energy across one of the glass surfaces without distorting visibility through the panel and with no serious reduction in the intensity of luminous transmission. In its present stage of development, the reflection of a glass surface treated with NESA is somewhat greater than that of untreated glass. However, both the intensity and the color variation of reflected light are minimized by laminating the surface to another plate of glass with an intermediate bonding layer of vinyl plastic.

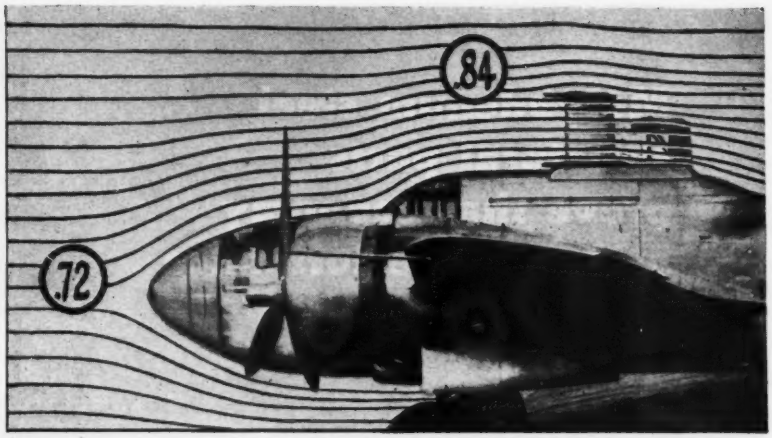
The unaided eye can detect no color differential in transmitted light and the visual characteristics are approximately the same as untreated glass when employed in vinyl laminates. Another characteristic of treated glass for aircraft windshields is that it actually strengthens them against impact at low atmospheric temperatures. Pittsburgh Plate Glass Company.

Landings Unlimited

A booklet, illustrated in color, describes the Republic Seabee. The range of utility of an amphibian over that of a landplane is stressed. The accessories and interior finish contributing to passenger comfort are described, as well as the radio equipment. Detailed performance data and technical specifications are listed. Republic Aviation Corporation.

Solenoid-Operated Valves

A new group of solenoid-operated valves has been developed for 3,000 lbs. per sq.in. pressure, for hydraulic and pneumatic equipment. The 1/4-in. size, four-way valve has provision for manual override. This unit, which has male ports designed to meet the requirements of specification AND-10050, weighs 2 3/4 lbs. and has a total pressure drop of 30 lbs. per sq.in. at 1.2 gal. per min. flow. The valve is spring loaded in the normal position. The actuating current is 16 amp. at 24 volts d.c., with a maximum holding current of only 1/4 amp. for continuous duty. Also available is a complete series of solenoid-operated on-off and special-cycle valves for 3,000 lbs. per sq.in. The Saval Company, Los Angeles.



How an airplane flying at a Mach Number of 0.72 produces higher speeds around the fuselage because the air is pushed aside. This constriction has made it possible for Martin engineers to record data at speeds of Mach Number 0.84.

How to Reduce the Cost of Aeronautical Maintenance

Bulletin AS-364 refers to the use of the manufacturer's chemical cleaning materials in the field of aircraft cleaning. It gives particular attention to paint stripping, cleaning of parts, steam cleaning, and special products for exterior and interior finishes. Turco Products, Inc., Los Angeles.

Power Unlimited

Wellwood Beall, Vice-President in Charge of Engineering-Sales, Boeing Aircraft Company, outlines the progress that has been made in increasing the power available for large airplanes and tells of the engineering problems involved in utilizing these greater power units to produce the increasing speed of which modern airplanes are capable. He traces the improvement in the efficiency of the reciprocating engine achieved during the past 15 years, as well as the improvement in propeller design, and proceeds to explore the possibilities of the gas-turbine and the ram-jet engine. He emphasizes the responsibility of the engineer in integrating the operation of the power plant with the particular aircraft in which it is installed, and quotes figures indicating the extent of the research and development work accomplished by the engineering department in designing aircraft capable of reaching speeds and altitudes of the present and of the visible future. A brief explanation of the principles upon which the ram-jet engine operates is given. *Boeing Magazine*, May, 1946.

Exploring the Transsonic Flight Region

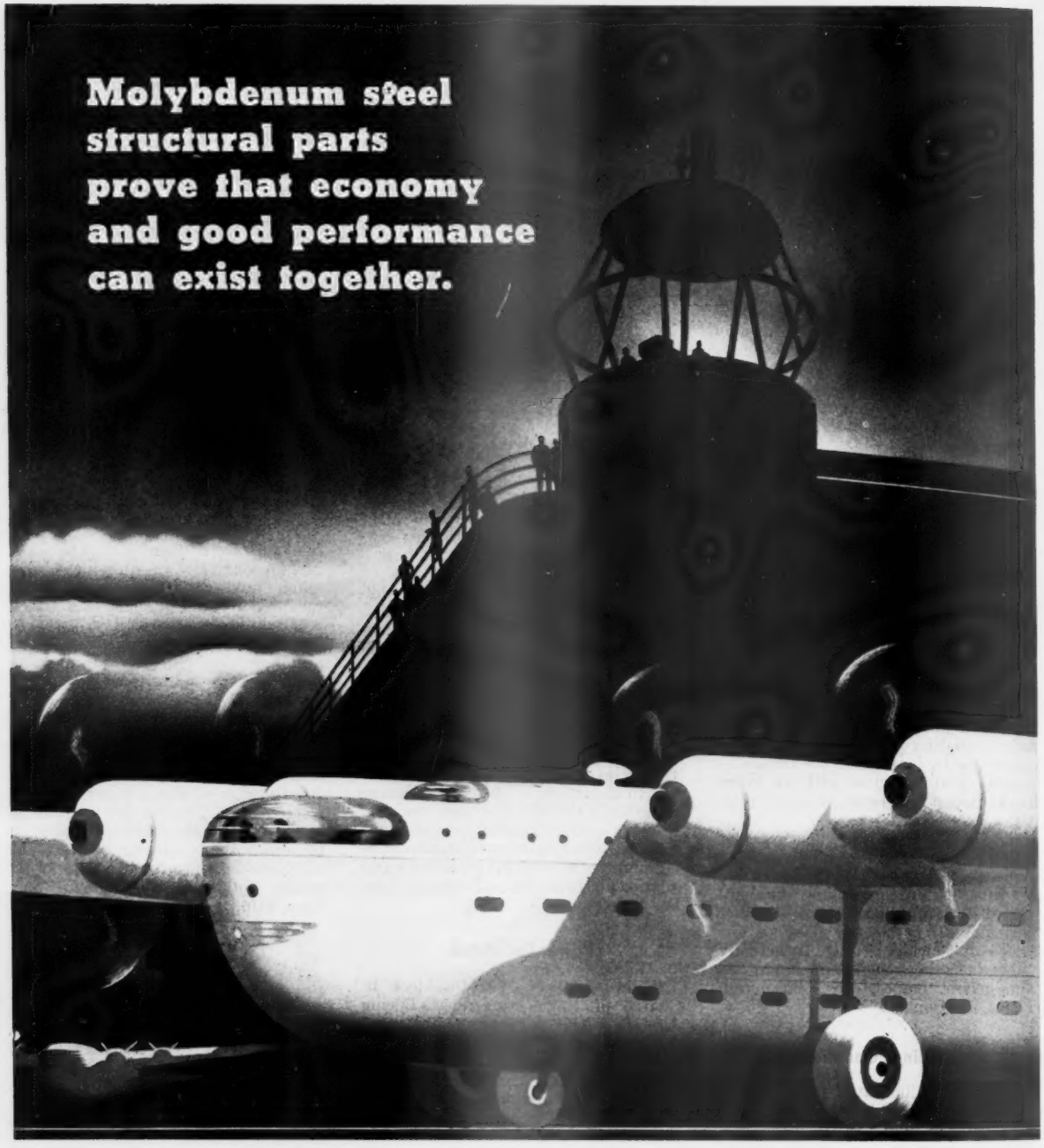
The work of engineers of the Aerodynamics Department of The Glenn L. Martin Company in studying aerodynamic problems by means of models mounted atop the fuselage of a Martin A-30 airplane is described. It was found that information about transsonic airflows could be obtained through actual flight testing without the limitations imposed by wind-tunnel operations. How this work was accomplished is outlined in nontechnical language, with details concerning the construction of a section of airfoil, its mounting on the fuselage of the bomber, and the tests made. The special instruments installed inside the cabin of the airplane to record the results of the test also are described. Charts show some of the results obtained. *The Martin Star*, June, 1946.

20-Year Partnership

The operations of Canadian Wright, Ltd., which for 20 years has acted as sales and service licensee of Wright Aeronautical Corporation, are reviewed. The growth of the Canadian company is traced from a small shop, employing no more than 25 persons engaged in overhaul of J-5 Wright Whirlwind engines, to an organization occupying 86,000 sq.ft. of floor space and having an additional plant in Vancouver to serve the manufacturing industry and armed forces on the Pacific coast. The work of the company in serving the Royal Canadian Air Force and in the manufacture of equipment for civilian flying in Canada is outlined. *Trade Winds*, Spring, 1946.

Lubrication of Air-Frame and Engine Accessories

The specific problems involved in the lubrication of the components of the air-frame and engine accessories are studied, as distinguished from the problems involved in engine lubrication alone. It is noted that these problems were relatively simple only a few



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years ago but they have become increasingly complex as the size and power of airplanes have increased, making necessary the installation of antifriction bearings for the control mechanisms. Details are given with regard to the development of special greases to meet these problems of lubrication. The greases are broadly classified into four types, each of which is described at considerable length, with specifications as set forth by the Army, Navy, and other users of modern aircraft. In a similar manner, specialty oils developed for aircraft are classified and treated. The service problems are reviewed and tabulations containing specifications for special aircraft greases and oils are reproduced. *Lubrication*, April, 1946.

Spin Test

How an airplane is made ready for spin tests is outlined in a short article. It recounts the spin testing of the Navy's new Martin Mauler. Special parachutes were designed, manufactured, tested, and installed in tubes in the rear of the plane under the fuselage, in place of the usual arresting hook. It was intended that, if the pilot were unable to make the plane recover from the spin, the chutes would have been released and were expected to be able to exert sufficient force on the craft to make it recover from the spin. Other safety provisions are outlined and figures are given with regard to the results of the test. *The Martin Star*, June, 1946.

The Work of the de Havilland Vibration Department, Parts I and II

Methods of studying vibration problems in the airplane structure, the propeller, and other components, as practiced in the plants of the de Havilland enterprise, are described in considerable detail. The functions of the company's vibration department are reviewed, with a brief history of the progress made in recent years in the design and application of strain gages. That leads to a description of present techniques and of the apparatus used to record the stresses. Explanations are given of how measurements are made of steady stresses in structures in tension or compression, and torsion stresses in tubes or shafts. Strain gaging of rotating structures is explained at length, with the aid of diagrams and photographs of instruments used in studying vibrations in a propeller, including an oscillograph record made by a propeller on a Napier Sabre engine. Vibration tests while in flight are outlined, as well as those made in the laboratory and in mobile units mounted in motor trucks. A large part of the apparatus employed was designed and constructed in the company's own shops.

Part II completes the account of rotational vibration measurement, referring to instruments developed by the company for recording the very high frequencies encountered in turbine impellers. It continues with a description of static vibration study by means of mechanical and electromagnetic exciters, and tests to determine what stresses a structure can withstand before failure. Procedures in applying destruction and fatigue tests follow, with comments on the results obtained and how the information is used in calculating design improvements to overcome the faults revealed. The article concludes with an outline of the work done in measuring fuselage vibrations from the standpoint of passenger comfort as well as structural strength. It is stated that the facilities of the company for vibration testing and measurement are available to the industry. *de Havilland Gazette*, February, 1946, and April, 1946.

The Whys and Wherefores of de Havilland Turbine Design

E. S. Moult, Chief Engineer of The de Havilland Engine Company, Ltd., traces the evolution of the aircraft gas turbine as a jet-propulsion power plant and as a combination propeller and jet unit. He explains the theory of jet propulsion in nontechnical terms. Using the Goblin gas turbine as an example, he outlines the reasons for adopting the single-sided impeller, straight-through combustion, cantilever suspension, and other design features, noting that a combustion efficiency of better than 98 per cent has been achieved. The limitations imposed by stress and temperature are stated to be capable of improvement through advances in metallurgy, leading to still greater efficiency by using richer fuel mixtures. It is predicted that gas-turbine power plants will provide more power, reduced weight, greater compactness, better performance, and comfort in the aircraft of the future. *de Havilland Gazette*, February, 1946.

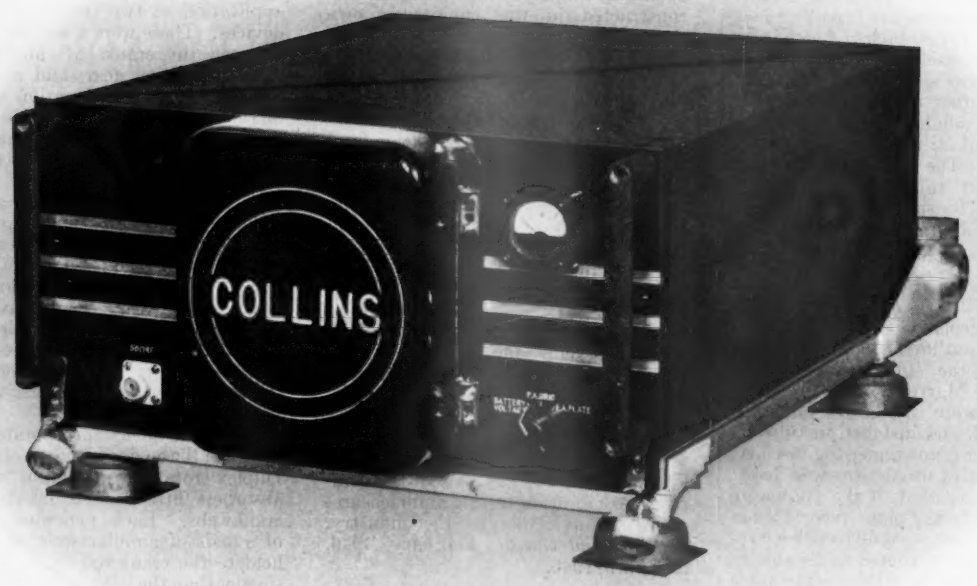
Gearing the Six-Cylindered Gipsy Queen

Torsional vibration problems in what is credited as the first six-in-line aircraft engine with geared propeller to be put into production, the Gipsy Queen Series 70, were solved by the application of two proved mechanical devices. These were a flexible coupling between the crankshaft and the epicyclic reduction gear, and a series of rotating pendulum vibration absorbers on the crankshaft. The flexible coupling is an adaptation of the Wellman Bibby spring coupling, in which the torque is transmitted through a grid type of spring, the segments of which are interfaced through teeth shaped like curved-face gear teeth in the periphery of the driving and driven members of the coupling. When resonance develops in the crankshaft system, the relative movement of the coupling members alters the effective span and stiffness of the spring rungs, resulting in a change in the natural frequency of the vibrating system.

The other device incorporated in the design of the engine is the set of Salomon Duplex rotating pendulum vibration absorbers fitted to six of the twelve crankwebs. Each pendulum consists of a pair of annular weights that are held to the crankweb by a pin that is smaller than the holes in the weights and the web. Rotation of the crankshaft throws the weights out centrifugally, but under the influence of torsional moment they can roll ahead or lag behind. This changes the inertia at every throw of the crankshaft, thereby changing the turning of the system. *de Havilland Gazette*, February, 1946.

Hermes under Test

In parallel columns printed in English, French, and Spanish, the procedures involved in structural testing the Handley Page Hermes transport are explained in nontechnical language. It is shown how the fuselage and wing construction are subjected to tests to determine the stress involved in internal pressurization, strength tests for the wings and control surfaces, drop tests for the undercarriages, and tests of the safety harness provided for passengers. Some of the testing equipment used in the plant is described briefly. *Handley Page Bulletin*, April, 1946.



Aircraft communication at its best

THE COLLINS 18S-1 transmitter-receiver is engineered for highest performance in aviation communications. It is specifically designed for commercial airlines and executive aircraft. Reflecting years of experience and proved dependability in the field of aircraft radio, the 18S-1 is new in every respect, and has performed superbly under flight tests.

Ten channels, with twenty crystal controlled frequencies are available for transmission between 2.5—10.0 mc. Power output from the transmitter is more than 100 watts. The receiver is controlled by a separate group of 20 crystals, and does not necessarily operate on the transmitting frequency. Quick, automatic frequency selection is provided, with all circuits tuned and ready to operate. Remote control encourages locating the unit with respect to proper weight distribution within the plane. The 18S-1 works into a 50 ohm transmission line.

A single 1½ ATR unit cabinet contains transmitter, receiver, and dynamotor power supply for the transmitter. The receiver operates directly from the 26.5 volt d-c source. The entire weight, including shock mount, is 60 lbs.

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THE 180K-1 antenna loading unit efficiently transfers the power output from the 18S-1 to any standard commercial fixed antenna. Remote controlled, pretuned operation for ten channels is provided. The nominal input impedance is 50 ohms. Weight, 10 lbs. Size, 7½″ h, 10½″ d, 12″ l.

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Los Angeles 13, California

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Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Engineering Personnel—Engineers with 5 or more years of helicopter experience in any one of the following lines: aerodynamics, stress analysis, vibration analysis, project engineering, and engineering flight test. Apply by letter to United Helicopters, 625 El Camino Real, Palo Alto, Calif.

Heating and Ventilating Engineer—Senior heating and ventilating engineer, familiar with the principles of heat exchange and air conditioning applicable to aircraft design, is required to act as Group Leader in the Design Office of a large aircraft manufacturing company in Montreal. Candidates should be graduate electrical, mechanical, or aeronautical engineers and should have at least 5 years' experience, including 3 years' specifically in the above work, and 1 year of supervisory experience. Applicants should write giving details of educational background, experience, salary expected, and availability to Canadair Limited, P.O. Box 6087, Montreal, Quebec, Canada.

Mechanics—Line Maintenance—Forty hours (rotating shifts). $1.26 per hour with periodic increases. Four years' minimum experience in multi-engined aircraft (C-54 experience desirable). Preference given for experience in electrical or instrument line maintenance and Aircraft and Engine Licenses. Contact Personnel Department, American Overseas Airlines, LaGuardia Field, N.Y.

Mechanics—Foreign Service: Paris, Iceland, Azores, Greenland. Foreman, $325 per month; lead mechanics, $325 per month; mechanics, $262.50 per month; $175 in addition to monthly salary for overseas duty. One year C-54 experience minimum, with an additional 3 years' experience in line maintenance, and Aircraft and Engine Licenses. Contact Personnel Department, American Overseas Airlines, LaGuardia Field, N.Y.

Instructor—Wanted by Department of Mechanical Engineering beginning in the fall quarter to teach undergraduate courses in aeronautics and courses in heat power engineering. Must have good academic training and some teaching experience; should have practical experience in aeronautical engineering and ability to do research. Salary up to $4,500 based on training and experience. Apply to Department of Mechanical Engineering, College of Engineering, University of Kentucky, Lexington 29, Ky.

Aeronautical Engineers—Group Engineers in stress, structural test, and aerodynamics; lead and major engineers in design, aerodynamics, stress analysis, and structural test wanted immediately for development and production engineering work on feeder-line airplane (Boeing 417) and military aircraft. Write Chief Administrative Engineer, Boeing Airplane Company, Wichita Division, Wichita, Kan.

Aeronautical Engineers—Qualified Engineers are urgently needed for development work on flight test instrumentation at Wright Field, Dayton. Attractive positions are open for research engineers (electrical, electronic, aeronautical, mechanical) with previous industrial experience in aircraft instrument development. Salaries range from $2,644 to $7,102 with the additional benefits of Federal Civil Service. Applicants may submit Civil Service Form No. 57 (obtained at local Post Office) to Secretary, Civil Service Board of Examiners, Air Matériel Command, Wright Field, Dayton, Ohio. Attention: TSFIS.

Research Designer—Airplane designer, with previous experience in applied mechanics, aerodynamics and stress analysis, to lead aircraft and missile design group. Advanced degree desirable. Thorough knowledge of jet propulsion necessary. Replies will be held in strict confidence. Write Cornell Aeronautical Laboratory, Employment Office, Buffalo 5, N.Y.

Thermodynamicist—With strong theoretical background to engage in research work in the field of jet propulsion. Advanced degrees preferred. Replies will be held in strict confidence. Write Cornell Aeronautical Laboratory, Employment Office, Buffalo 5, N.Y.

Aeronautical Engineers—The U.S. Naval Air Station, Jacksonville, Fla., requires the services of several highly qualified aeronautical engineers with power-plant or structures background, and preferably with some production experience. Salaries range from $2,980 to $5,180 per annum. Applications are now being accepted. Interested persons may obtain Civil Service Application Form 57 from their local post office and forward, completely filled out, to the Recorder, Industrial Relations Department, U.S. Naval Air Station, Jacksonville, Fla.

Aeronautical Engineers—Excellent opportunities for graduate engineers in design, stress analysis, or layout now exist for personnel interested in working on commercial-type aircraft. Write, giving education and experience, to the Personnel Department, Cessna Aircraft Company, Wichita 1, Kan.

Engineers—The Army Air Forces Air Institute of Technology being established at the Air Matériel Command, Wright Field, Dayton, has several openings for qualified professors and engineers to administer and to teach on a graduate and undergraduate level in the College of Engineering (Aeronautics). Starting salary ranges from $4,300 to $7,175, depending on position and qualifications. Employment will be effected in accordance with provisions in Civil Service Regulations. As faculty member, applicant should be capable of expanding into a research and consulting relationship with the various A.M.C. Engineering Division Laboratories. Write Commanding General, Air Matériel Command, Wright Field, Dayton, Ohio, Attention TSPCP-1, setting forth personal data and qualifications, education and experience; or forward Civil Service Form 57, available at post office.

Aeronautical Engineers—Thoroughly trained, experienced, and qualified to deal with problems in aerodynamics and thermodynamics. Opportunity to participate in development work arising from the application of advanced types of airplane power plant and resulting high-speed performance. Write giving education and experience, to the Industrial Relations Department, Consolidated Vultee Aircraft Corporation, Vultee Field Division, 842 South Lakewood Blvd., Downey, Calif.

Aerodynamicists—Immediate work is available for three qualified engineers with Kaiser Fleetwings, Inc. First man must be a stability and control specialist with at least 2 years' experience, some experience with problems related to flight at transsonic and supersonic speed. Second man must be a specialist in aircraft performance estimation with a minimum of 2 years' experience, familiar with compressibility phenomena and with means of accounting for these phenomena in performance estimation. Third man must be familiar with general aerodynamics work and possess some knowledge of the characteristics of ram jet, pulse jet, and rocket jet engines. Good background in thermodynamics is necessary. Address reply to G. G. Cudhea, Chief Engineer, Kaiser Fleetwings, Inc., Bristol, Pa.

Transmission Engineer—Long-established aircraft manufacturer engaged in helicopter development requires services of mechanical designer on gear transmission work. In staff specialist capacity, position offers unusual opportunities. Aircraft experience desirable but not required. Kellett Aircraft Corporation, North Wales (Philadelphia), Pa.

Assistant Professor—To teach applied mechanics, strength of materials, and fluid mechanics. A young man with M.S. degree preferred. Applicant should have special qualifications in the field of hydraulics and fluid mechanics. Opportunity to work in fluid meters research and the development of a fluid mechanics laboratory. Address inquiries to Department of Mechanics, University of Oklahoma, Norman, Okla.

Instructor in Aeronautical Engineering—To teach courses in general aeronautics and stress sections. Must have aeronautical engineering degree. Opportunity to do graduate work. Appointment for September 15, 1946. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Assistant or Associate Professor—To conduct senior and graduate courses in airplane stress and design group. Must have M.S. degree in Aeronautical Engineering and experience in industry or teaching. Appointment for September 15, 1946. Salary open. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Aerodynamicists—College graduates with sound theoretical training and at least 1 year of graduate study in compressible subsonic flow and supersonic flow to do research and test work in the Supersonic Wind Tunnel of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland. This is by far the largest operating supersonic wind tunnel in the country. Remuneration in accordance with qualifications. Write, giving education and experience, to The Commanding General, Aberdeen Proving Ground, Maryland, Attention: Director, Ballistic Research Laboratories.

Technical Representatives—To perform industrial representation within their resident state, county, or city for manufacturers and associated concerns throughout the country. Must have permanent position with an established company and complete domestic and technical information. Address inquiries to George E. Harris Associates, Rooms 314-318, Administrative Building, Municipal Airport, Wichita, Kan., Attention: G. E. Harris.

Design Engineers, Stress Analysts, Layout and Draftsmen—Needed for development work on experimental military aircraft, as well as production engineering. Address inquiries to Curtiss-Wright Corporation, Airplane Division, Columbus 16, Ohio, Attention: R. C. Blaylock, Chief Engineer.

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ENGINEERING GRADUATES

Excellent opportunity for mechanical and aeronautical engineering graduates for training in our experimental test laboratory, after which opportunity will be offered for advancement into engineering assignments such as research into reciprocating and other new advanced types of power plants. Reply giving age, experience and education, to Wright Aeronautical Corporation, Employment Division, Wood-Ridge, New Jersey.

McDONNELL AIRCRAFT CORPORATION of St. Louis has openings for Senior Aerodynamicists for work on pilotless aircraft. Three years' experience in Aerodynamics required. Experience and training in Supersonic Aerodynamics desired but not essential.

Write giving full details to

McDONNELL AIRCRAFT CORPORATION
Lambert-St. Louis Municipal Airport,
Box 516, St. Louis (21), Missouri

McDONNELL AIRCRAFT CORPORATION has openings for several graduate engineers with two to ten years experience in aircraft flutter and vibration analysis, engine vibration analysis, or related fields. Salary and position commensurate with ability and experience.

Write

McDONNELL AIRCRAFT CORPORATION
Lambert-St. Louis Municipal Airport,
Box 516, St. Louis (21), Missouri

Aircraft Engineering

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Research Engineer—Theoretical Aerodynamicist or Thermodynamicist with advanced degree to engage in research on certain high-speed developments. For details write Box 1-T, Richmond 2, Va.

Design Engineers; Draftsmen—Opportunities now exist for qualified design engineers and draftsmen for work on the new Stratocruiser C-97 military transport and other new developments. Here is an opportunity to become associated with one of the world's leaders in aircraft design and production and to participate in the design of the aircraft of tomorrow. Write to the Engineering Department, Boeing Aircraft Company, Seattle 14, Wash.

Aerodynamicists and Thermodynamicists—Research minded and with good theoretical background, to engage in research work on high-speed and jet propulsion developments, advanced degrees preferred. Salary commensurate to qualifications. Replies will be held in strict confidence. Write, giving education and experience, to Cornell Aeronautical Laboratory, Buffalo 5, N.Y.

Aircraft Engineers—Immediate, permanent openings for aircraft engineers with 5 years' experience in aerodynamics, structural design, and C.A.A. airworthiness requirements with Southern California aircraft manufacturer. Air-mail qualifications and recent photo to P.O. Box 29, Burbank, Calif.

Radio, Electronic and Telephone Engineers, Electronic and Mechanical Draftsmen—One of the largest manufacturers of a wide variety of electronic and communications equipment in the world is fully prepared and ready with an ambitious postwar program. Write to Personnel Manager, Federal Telephone & Radio Corp., 591 Broad Street, Newark, N.J.

Aircraft Stress Engineers thoroughly familiar with the analysis of aircraft structures, aircraft controls, and all component parts for work on helicopters. Excellent opportunities for personnel interested in rotary-wing aircraft. Apply by letter, giving references, to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Lansdowne Avenue above State Road, Upper Darby, Pa.

Aeronautical Engineers—for immediate work, the long-established Aeronca Aircraft Corporation seeks project engineers, design engineers, weight engineers, and layout draftsmen. These positions offer unusual permanent opportunities with the pioneer light-plane company of America for qualified men. Write in complete detail to Aeronca Aircraft Corporation, Box 00, Middletown, Ohio.

555. Assistant, Associate, or Professor of Aerodynamics—To teach graduate courses in aerodynamics, especially aerodynamics of gas turbines, at well-known eastern school. Opportunity to engage in research. Advanced degree required and research experience preferred.

554. Aerodynamicists and Aeronautical Engineers—Positions available for highly qualified technical personnel with good theoretical background to engage in development and test work in stability and control, high-speed aerodynamics, and axial-flow compressors. Salary in accordance with qualifications. In reply please give brief summary of personal qualifications, education, and experience. As required by the Civil Service regulations now in effect, preference in appointments to these positions will be given in the following order: (1) persons entitled to ten-point military preference, (2) persons entitled to five-point military preference, (3) former Federal employees, (4) persons who do not come under (1), (2), or (3).

550. Engineer—Qualified engineer capable of serving as liaison between development engineering and factory production in aircraft electronics and related fields. Background of shop practice essential to assist and guide design engineering in production methods. Unusual opportunity for permanent position.

The number preceding each notice represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

548. General Manager—For large and active aircraft concern located in the East. In addition to proved administrative ability and all other qualities suited to a general manager must have many years of successful aircraft production experience. Good position for a good man. State qualifications. Correspondence will be kept confidential.

538. Engineers—Experienced engineers wanted for project engineering and design evaluation work on pilotless aircraft. Aeronautical graduates with training or experience in electronics preferred. Location Washington, D.C.

534. Draftsmen—Personal plane manufacturer and government contractor located in New York Metropolitan area is seeking qualified airplane draftsmen. Engineering degree not necessary although aeronautical experience desirable.

529. Service Manager—For major personal plane manufacturer located in New York Metropolitan Area. Good opportunity.

527. Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in preliminary investigations of new aircraft designs and airplane performance. Salary between $3,640 and $4,300 per year. In applying please give brief sketch of personal qualifications, education, and experience.

526. Aeronautical Engineer—Position open in Washington, D.C., for aerodynamicist with design and research experience in stability and control and high-speed aerodynamics. Salary between $4,300 and $5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience.

518. Power-Plant Design Engineer—For supervision of design of power-plant installations. Will also supervise design of mechanical equipment, including heating and ventilating equipment, hydraulic, vacuum, and oxygen systems and cabin supercharging systems in airplanes. Must have mechanical or aeronautical engineering degree with over 7 years' experience in this work in aircraft industry. Position available in Midwest airplane company.

516. Mechanical or Aeronautical Engineer—Graduate with several years' experience in conducting aircraft-engine tests, for research assistant in engine laboratory of Eastern university. Position permits applicant to carry parttime graduate work; may lead to teaching affiliation. Salary commensurate with ability and experience.

512. Assistant Professor of Aeronautical Engineering—To teach courses in aircraft design and aircraft structures in aeronautical engineering department of large university in Southwest. Opportunities for research in structures and in newly organized Navy Ordnance program provide for full year-round employment. Applicants should submit detailed record of education and experience.

511. Aeronautical Engineers—To teach mathematics, primary and advanced aeronautical engineering subjects including design and stress analysis in a Midwestern university.

498. Project Engineer, Chief of Structures—Excellent opportunity for qualified men with a manufacturer of medium sized aircraft. Commercial experience preferred but not necessary.

490. Assistant or Associate Professor—Sought by Aeronautics Department of Engineering College to teach undergraduate and graduate courses in aerodynamics, aircraft structures, or aircraft propulsion. Must have good academic training and teaching experience; constructive interest in aeronautical research and development, preferably industrial or laboratory experience in this field. Starting salary range: $3,000 to $5,000, depending upon qualifications.

477. Instructor—In department of mechanical engineering to teach mainly aerodynamics, aeronautical design, and develop aeronautical laboratory. Advanced degree desired. Appointment September as Instructor or Assistant Professor, dependent on qualifications. Location Philadelphia.

476. Design Draftsmen—To prepare working plans and detail drawings of new or improved products, sketching from engineering notes; checking designs for engineering accuracy; supervising some Detail Draftsmen who may be assisting. At least 5 years' experience required. Salary of $50 to $70 for 40-hour week, time and one-half for any overtime.

466. Aeronautical Engineers—Prominent light plane manufacturer located in New York area seeking qualified aeronautical engineers including aerodynamicists, stress analysts, loftsmen and draftsmen, particularly those experienced in molded plywood and sheet metal structures. Military and civil contracts.

463. Assistant Chief Aircraft Designer—Good background and experience in civil aircraft and conversant with C.A.A. requirements. Permanent position with aircraft manufacturer in central eastern coast area. Reply by letter giving particulars as to experience, salary desired, and date available.

462. Chief Stressman with C.A.A. requirements experience, and **One or Two Assistants,** to take charge new project. Permanent position with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position.

461. Layout and Detail Draftsmen, Senior and Junior—Required for progressive aircraft program with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position.

460. Aircraft Design Engineers—Immediate permanent openings for design engineers with good experience in aerodynamics, structural design and C.A.A. airworthiness requirements with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position.

458. Designing Draftsman—Design ignition components of electronic and electromechanical nature. Also do follow-up on experimental orders. Should be conversant with design for low-cost production. Starting salary of $70 to $85 for 40-hour week; time and one-half for any overtime.

456. Assistant Engineer—Design work, test work, test analysis, and creative development work in high-frequency ignition and electrical test equipment program. Must have experience in modern electronic design, test and development methods. Starting salary of $4,200 to $4,800.

448. Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in structural design and research. Salary between $3,640–$5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience.

443. Stress Analyst—Engineer with experience in design of rotary wing aircraft rotor blades. Must have thorough knowledge of rotor blade stress and aerodynamic analysis procedure, experimental procedure for determination of static and dynamic stresses and fatigue research methods. Permanent position involving study of wood, metal, and plastic blades.

442. Assistant Professor of Aeronautical Engineering—Must have experience in structural analysis and design. Permanent position. Appli-

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Minneapolis-Honeywell Control systems have become established in the air. The needs of the Air Forces in wartime accelerated our research and development and advanced our Aeronautical program by many years, over the pace it might have taken in its normal growth.

The business of Honeywell is automatic control. The air is but a new territory into which our efforts have expanded and in which our competence has been demonstrated.

The Honeywell Electronic Autopilot and Electronic Turbo-Supercharger Control are standard with the A.A.F. where precision and reliability are demanded. These, together with the Honeywell Electronic Fuel Gages and Temperature and Pressurizing Control systems have also won acceptance in the transport field. Many more control systems are under development.

Aviation tomorrow will be even more dependent upon automatic control. That is a science Honeywell has pioneered since 1885. We welcome the challenge that aviation's need presents to the Honeywell organization. We like our wings. They are a part of Honeywell and will be a continuing factor in its future.

Harold W Sweatt

HAROLD W. SWEATT, President.

MINNEAPOLIS Honeywell

AERONAUTICAL DIVISION

CREATIVE ENGINEERING

MAKERS OF THE FAMOUS M-H ELECTRONIC AUTOPILOT, USED ON FOUR-ENGINED BOMBERS.

cants should furnish details describing education, experience, and personal data. College located in Virginia.

434. Assistant Professor—To conduct senior and graduate courses, develop laboratory, and direct research in aircraft power plants, with emphasis on standard aircraft engines and accessories. Advanced degree preferred. Position with an established aeronautical engineering department of a large eastern university. Appointment September, 1946. Salary open.

414. Aircraft Layout Draftsmen—Familiar with layout and design of aircraft sheet metal structures, controls, mechanisms, power plant, electrical systems and equipment. Excellent opportunities for experienced personnel interested in helicopter design.

413. Assistant or Associate Professor—To conduct undergraduate and graduate work in theory, design, and research in propellers and jet and rocket propulsion systems. Applicant should have at least one graduate degree and a sound theoretic and applied background in the thermodynamics and aerodynamics of propulsion systems. Large midwestern university.

370. Project Engineer—Experienced and talented design man to undertake the responsibility for a new aircraft project from inception to completion. Plant located on eastern seaboard. Salary scale above average. Write full particulars.

362. Airplane Salesmen—Large established producer of personal aircraft seeking several qualified airplane salesmen with both flying and merchandising experience. Interview in New York.

340. Associate Professor of Aircraft Structures—To teach senior and graduate courses in aircraft structural theory, develop structures laboratory, and direct graduate structural research work. Practical experience necessary. Advanced degrees preferred. Permanent position. Leading State University. Location—Midwest.

339. Associate or Full Professor—To teach advanced courses and direct research in the Aircraft Power Plant Design field. Recent experience in turbine and jet engine design and testing necessary. Advanced degrees preferred. Permanent position, large Midwestern university. Can wait six months if necessary.

338. Assistant or Associate Professor of Aerodynamics—Young man with Ph.D. to teach graduate courses in theoretical aerodynamics and direct theoretical and experimental research in this field. Research experience necessary. Position permanent. Midwestern State University.

337. Associate or Professor of Aerodynamics—To teach performance, control, stability and develop correlating flight test and flight instrumentation courses for large Midwestern university. Position permanent. Practical experience necessary. Advanced degrees preferred.

322. Patent Engineer—Familiar with patent disclosures and procedures. Essential helicopter industry. Salary commensurate with experience and present earning capacity.

AVAILABLE

Engineer—B.S. in M.E., Ae.E.; desires responsible executive position, preferably with personal plane manufacturer. Has 20 years' design, production, and executive experience which merited brief biography in *Who's Who in America*. Address inquiries to P.O. Box 503, Mt. Vernon, N.Y.

Engineer—E.E.; Executive or Administrative. Thirty-one years old. Ten years' experience electronics, servos, aircraft and industrial controls, ignition, sales engineering. Qualified in automatic temperature and propeller pitch controls and automatic pilots. Previous positions: head of research lab, central office engineer, assistant chief engineer, chief engineer. Capable of directing activities and handling men. Responsible position. Available immediately. Address inquiries to Box 271, Roslyn, L.I., New York.

560. Industrial and Aeronautical Engineer—B.S. in Industrial Engineering, major in Aeronautical Engineering from Iowa State College, 1943. Age 25. One year's experience with large West Coast aircraft concern. Served as an Aeronautical Engineering Specialist for over a year in the Navy Air Corps. At present, Production Officer at a Naval Air Station in charge of all repair shops and supervision of 400 men. Work includes checks, maintenance, repairs, and overhauls of latest-type Navy aircraft. Desires responsible position in the production department of an aircraft firm. Would also accept stress analysis or aerodynamicist position.

559. Engineer-Journalist—Three years' study in aeronautical engineering at Rensselaer Polytechnic Institute. Two and one-half years' service with the U.S. Marines. Two years' engineering under the ESMWT night schools; 3 years' experience in the engineering department of a large eastern aircraft concern as an engineer and draftsman; and 12 years' practical experience in photography, plus journalism experience in the service and in civilian life. Desires permanent position with a good technical publication or in the advertising, merchandising, or public relations department of a large eastern aircraft concern, preferably in vicinity of New York.

558. Aeronautical Engineer—B. of Aero.E., New York University, 1944. Two years of liaison engineering experience in U.S. Navy, plus previous limited association with large manufacturer as Aerodynamicist and Flight Test Engineer. Desires position with small organization in New York area, not necessarily aircraft, to do design and development work.

557. Aeronautical Engineer—B. of Aero.E., New York University and 2 years of law study. Four years' experience in static test and structural flight test experimental work on Naval aircraft. Experience in all phases of experimental work involving instrumentation and tests of aircraft structures. Plans to complete LL.B. degree in 1 year of evening school. One year parttime experience with patent attorney. Desires position in New York Metropolitan or Los Angeles area as patent engineer or aeronautical engineer. Opportunity desired for working into engineering-law position.

556. Production and Service Engineer—Nine years' practical experience in aircraft planning, scheduling, manufacturing processes, and service engineering with large eastern aircraft manufacturer. Experience includes planning and scheduling of production aircraft and spare parts, improvement and simplification of manufacturing processes, especially machining processes, and the compilation and editing of erection and maintenance manuals for production and experimental aircraft. Veteran of World War II. Desires position of administrative capacity in production management or service engineering.

553. Aeronautical Engineer—Canadian, age 28, married. Four years' responsible work in aircraft manufacturing and air-line engineering; previous writing and administrative experience. Broad educational background, including American. Thoroughly familiar with both American and British airworthiness requirements. Interested in development engineering. Continental or foreign location acceptable. West Coast preferred.

551. Aeronautical Engineer—General design experience on wood and metal aircraft, Army, Navy, and C.A.A. Considerable electrical and radio experience. Present standing Electrical and Radio Group Leader. Desires salaried position in vicinity of New York City.

549. Physicist—M.I.T. graduate. Five years' general aerodynamic experience. Two years on supersonic airflow, including the design and development of a supersonic wind tunnel. Three years on engine cooling and airplane performance. Six years' general manufacturing experience. Wants responsible position, preferably in a missile development program.

547. Aeronautical Engineer—Assistant Professor of Aeronautical Engineering at large state university desires change. Has M.S. in Aeronautical Engineering; 8 years of teaching; industrial, consulting, and research experience in many phases of aeronautical engineering. Private pilot. Prefers university position with research and consulting possibilities. Will consider responsible industrial position.

546. Field or Sales Engineer—Seven years experience in foreign and domestic field in installation and sales engineering for major engine company. Desires field or sales engineering position with engine or air-frame company. Well established contacts on West Coast and Buffalo area. References and background available upon request.

545. Aeronautical Engineer—Six years' experience in engineering as Assistant Chief of Structures, Project Engineer, and on Army aircraft maintenance. Desires responsible engineering position with company developing roadable-type aircraft.

544. Aeronautical Engineer—B.A. in Ae.E. Recently discharged from U.S. Army. One year's experience in design of wooden gliders and metal cargo planes. Six months' experience in research analysis in jet propulsion. Also experienced in helicopter design. Excellent references.

543. Experimental Test Pilot—Five years of experimental and production flight-testing of fighter, dive bomber, and attack-type aircraft. All experience has been with contractors. Approved by Army and Navy for demonstration test work. Commercial license, single- and multi-engined ratings, instrument rating, instructors rating. Recent experience in jet-propelled and other high-performance experimental aircraft. Interested in flying or nonflying position offering future.

542. Sales and Service Engineer—Ten years of varied experience in the aircraft industry, both in fixed and rotary wing. Four and one-half years' experience in Sales Engineering, remaining experience in aircraft design. Desires connection with personal aircraft manufacturer or sales agency in the New York area. Holds valid private pilot certificate.

541. Translations—Aeronautical engineer and physicist would translate German technical papers and books into English. Thoroughly familiar with terminology in both languages.

540. Executive Accountant—Desires to join a progressive company as Treasurer, Controller or financial officer, or their chief assistant. Eight years' experience as Treasurer, Secretary. Also in plant management with one of the largest light-plane manufacturers. Has splendid banking connections. Desires to return to the aviation field. Willing to go to any part of the country, but prefers East or Middle West. Salary open, depending on future possibilities. Available within 30 days.

539. Technical Writer—Editor—Writing problems expertly handled by former editor of aircraft manuals. Low cost, confidential service on any written work from minor corrections to rewriting and ghostwriting. Reports, articles, speeches, and monographs guaranteed to be put into clear, forceful, letter-perfect English.

533. Production Executive—Aeronautical Engineering degree, M.I.T. graduate. Industrial management experience. Eight and one-half years in the aeronautical field, including engineering design and layout, research and process, manufacturing and matériel, engineering officer U.S. Navy. Seeks executive or administrative post in field service and maintenance, factory and production management, matériel, or as line assist-

ant to top executive. Available one month's notice.

532. Aeronautical Engineer—Bachelor of Aeronautical Engineering Degree from New York University with honors. Age 25. Two years' experience in design and research of aircraft propellers involving original administrative work on all phases of propeller design, theory, flight, testing, and production. Most original designs used by the services during the war. Flying experience. Two years' administrative experience as an officer in the U.S. Navy. Familiar with all phases of aviation. Desires responsible position in development, research, or administration in aeronautical organization with future. Has the initiative and ability to get things done. New York area preferred but not necessary. Excellent references.

531. Management Executive—Mechanical Engineer (1924), now Production Manager of medium-sized organization. Twenty-two years' practical experience in aircraft production, 12 years as executive in production control, manufacturing and plant management. Familiar with latest metal and wooden aircraft manufacturing techniques. Able leader, efficient organizer, experienced in labor relations. Expert in setting up and operating production programs of new aircraft. Writes and speaks fluently English, French, and German. Desires permanent position with well-established organization where knowledge, experience, initiative and results are of prime importance.

530. Design Engineer—Seven and one-half years' well-rounded aircraft design experience, including 4 years' rotary wing. Engineering administrative experience. Three years' experience power plant; group leader, controls; group leader, preliminary design; design engineer, general. Location open.

525. Aeronautical Engineer—Age 32. Professor of Aeronautical Engineering with 5 years' administrative experience as head of department in large engineering college. Industrial experience. Experience in all phases of theoretical and applied aerodynamics, performance, stability, and preliminary design. Will consider responsible position with accredited college or university, research organization, or industrial concern.

524. Electrical and Aeronautical Engineer—Has done graduate work in electrical and aeronautical engineering. Four years' experience as Chief Inspection Supervisor of a leading aircraft factory. Certified Ground Engineer. Desires contact with interested aircraft manufacturers or air lines for business enterprise in the East.

523. Aeronautical Engineer—B.A.E., New York University. One year aeronautical research experience. Four years' stress analysis, liaison, design, production expediting with two large aircraft manufacturers. Familiar with aircraft fabrication practice. Desires responsible production management position.

522. Mechanical Engineer—Native Polish; Master of Science degree in Engineering. Would like to translate Polish and Russian scientific and technical papers.

521. Manager—M.I.T., 1922, Engineering, Administration, Mechanical and Electrical Engineering Option. Twenty-three years' experience in industry as Industrial Engineer, Plant Engineer, Production Manager, General Manager. Last 5 years with prominent U.S. corporation as General Manager in Divisions manufacturing aircraft generators, motors, controls, and marine navigational instruments and mechanisms. A complete résumé will be sent upon request.

519. Field Representative—Quick to analyze and detect trouble. Engineer-mechanic training. Formerly technical representative for Wright and Ranger. Constellation experience gained at Lockheed Service, Burbank. Many years with Pan American Latin American Division. C.A.A. certificates. Extensive knowledge aviation fuels and oils. Free to travel. Available to progressive company.

517. Aeronautical Engineer—Five years' experience with a leading aircraft manufacturer. Extensive experience in specification writing, weight and balance control, layout and design. Inventive ability and production minded. Experienced in supervising a large group. Desires a permanent and responsible design position in progressive organization in New York area where his experience and abilities can be fully utilized.

515. Aeronautical Engineer—1938. Two years as detailer on hydraulic, mechanical, and electrical equipment for aircraft. Four years as development engineer in the research department of a large aircraft company; was partially responsible for complete engineering (basic design, performance prediction, prototype construction, and flight test) of a small airplane. Now directing the activities of a group of mechanical, chemical, and industrial engineers as Supervisor of Production Engineering and Tooling for a non-aircraft company. Desires to re-enter the aeronautical field in a responsible position in development work for an aircraft company. Would be particularly interested in assuming responsibility for the complete development of a new private airplane project.

514. Aeronautical Engineer and Pilot—B.S. in Mechanical Engineering, M.S. in Aeronautical Engineering, both from M.I.T. Six months' experience as aerodynamicist with large aircraft company in design and performance analysis of large transport and military aircraft. Familiar with C.A.A. performance and operating requirements of transport aircraft. 1,700 hours flying experience in all types of aircraft includes 1,300 hours of twin- and four-engined time. Two and one-half years in Air Transport Command as pilot in air-line operations with some administrative experience as operations officer. Commercial pilot, single- and multiengined land, flight instructors' ratings. Six months' administrative experience with small nonaeronautical manufacturing concern. Prefers position involving flying.

513. Aeronautical Engineer—B.S. in Ae.E., Purdue University; M.S. in Ae.E., New York University; studying for Sc.D. at M.I.T. Age 25, single. Desires position as aerodynamicist.

510. Mechanical Aeronautical Engineer—B.S.M.E. (Aero Option); 29 years old; 6 years' experience on propellers and propeller accessories and manufacture of precision parts. Two years as design engineer on helicopter rotors and controls. Some experience in textile machinery and power chucks. Desires responsible position as design or project engineer in Eastern area.

508. Aeronautical Engineer—B.S. in Ae.E. Three years' experience as assistant project engineer with prominent light plane company. One year as research engineer. Experienced in structural design, static testing, aerodynamics, and flight-test work. Familiar with C.A.A. requirements. Married; 28 years old; private pilot.

507. German Translations—Accurate translations of German technical literature in aeronautics and related sciences.

506. Aeronautical Administrative Engineer—Englishman with 18 years' aeronautical experience; A.F., Royal Aeronautical Society; Mechanical Sciences Degree (B.A. Cambridge University). Spent from July, 1938, to December, 1945, on British Government service in U.S.A. At present with Aeronautical Inspection Directorate in England. Speaks some French and a little Polish. Desires position with commercial air line anywhere, but preferably in Europe.

504. Aeronautical Engineer—B.S. Ae.E. from the University of Texas. Member of Tau Beta Pi and Pi Tau Sigma. Some postgraduate work. At present is Ensign (A) L, U.S.N.R., with duties as administration officer at a naval air station. Prefers work in design or aerodynamics.

503. Aeronautical Engineer—B.S. in Ae.E., B.S. in E.M. Five years' experience in design, layout, and stress analysis of large and small military and commercial airplanes with major aircraft companies. Now holds Structural Engineer rating. Experience in supervision of stress analysts, liaison engineers, and salvage engineers. Well grounded in preliminary design. Desires responsible position in aircraft or other concerns utilizing light metal stressed construction in Mexico or other Latin-American country. Available immediately. Details upon request.

501. Aeronautical Engineer—Young, Chinese; 4 years' engineering experience; excellent connections. Desires a permanent and responsible engineering, sales, or technical position with aviation company or allied industry in China or in the Far Eastern territory.

500. Pilot—Engineer—B.S. in Ae.E., 1943. World War II veteran. Two years in Army Air Corps on heavy and very heavy bomber-type aircraft. Holds valid commercial pilot certificate. Prefers position involving engineering and flying but will consider engineering alone. Will locate anywhere.

499. Aeronautical Engineer-Aerodynamicist—B.S. Ae.E. Ten months' research experience testing wings, tail surfaces, propellers in wind tunnel. Six months' aircraft-engine research and development. Available immediately. New York area preferred.

496. Aeronautical Engineer—World War II veteran; B.S. in GE with AE option from Georgia Tech. Twenty-four years old; 2 years', 8 months' experience in the development of aircraft engines (conventional and jet) and propellers in the Engineering Division, Air Technical Service Command, Wright Field. Will locate anywhere. No objection to traveling.

495. Manufacturing Executive—Twenty years' experience in engineering and production, both United States and England. Desires connection with small concern where experience and ability can prove results. East Coast preferred. Available one month's notice.

494. Airline Engineer—For embryo air lines in need of financial analyses and operational and management studies. Has two aeronautical engineering degrees (working for third). Six years' aeronautical experience—air line, manufacturing, teaching.

493. Power-Plant Designer—Age 26, Mechanical and Aeronautical degrees. Five years' experience with power-plant installation problems including cowling and cooling, duct design, and exhaust systems. Recent experience in turbojet engine installation work, including induction systems, tail pipe, and nozzle. Excellent references.

491. Aeronautical Engineer—(New Zealand). First Class Honors, B.Sc. Degree at London University. Three years' postgraduate work in mathematics. Eight and one-half years' experience in major English aircraft firm, including 2 years in workshops, 1 year in wind tunnel, 3 months in stress department, and the remainder on aerodynamics and project design, such as performance, general aerodynamics, wing section theory and design, and flutter and stability control (for which now responsible). Three years on flight-test work as observer, combined with above work. Desires responsible engineering position. Available immediately, subject to travel facilities from Great Britain.

488. Engineer—Design or Administrative—Twenty years' practical experience in aircraft design and administration with well-established firms. Design experience includes preliminary, proposal, and manufacturing phases of both fixed and rotary wing aircraft. Desires position of responsibility in either design or administration. East Coast preferred.

487. Engineer—Aeronautical, Sales and Personnel—Ex A.A.F. Major, recently released by Air Technical Service Command. Age 32; married. Military experience: 3 years as Engineering Officer at one of largest bomber plants, assisting

contractor in handling engineering with prime designer and A.A.F.; approximately 1 year as service liaison engineer. Civilian experience: 1 year as Director of Personnel and Labor Relations for a leading aircraft accessory manufacturer; 3 years as sales engineer, and creator and organizer of that department for same company; 3½ years' diversified experience in retail sales, aircraft and allied industry production and engineering. Desires connection wherever experience can be best utilized. Excellent references.

486. Aeronautical Engineer—Graduate with 12 years' practical experience in aircraft-engine design. Familiar with engineering, development and testing of superchargers. Two years' experience as Chief Engineer in plastics plant for aircraft turrets and noses. Desires engineering position preferably supervisory. New York area preferred.

485. Pilot—Marine Air Corps; age 24. Commercial license with single, twin, land ratings. Partial college education in business administration. Previous practical business experience; small-scale sales experience. Desires position with aviation firm or aviation products firm in sales-contact, field representative work. Future opportunity primary consideration; salary secondary.

484. Aeronautical Engineer—B.S. Ae. Navigation and drafting experience in U.S. Army Air Forces. Desires position as draftsman or aerodynamicist with air line or manufacturer. Location open.

483. Aerodynamicist—B.Aero.E. with distinction from the University of Minnesota; age 26, married. Four full years' experience with prime Navy contractor in stability and control, compressibility, wind-tunnel test, performance, and aerodynamic design of all types of aircraft. Desires position with aircraft, business, or educational organization. Opportunities to apply knowledge and to advance are of primary interest; salary secondary. Any location considered. Available immediately.

482. Research Professorship—or equivalent nonindustrial research connection is desired by aircraft engineering executive, who wants to change from industrial work to fundamental research in applied physics and theoretical aerodynamics. Sc.M. in Aeronautical Engineering from Massachusetts Institute of Technology. Twenty years' experience as head of aircraft engineering department.

480. Physiological Psychologist—Ph.D. 1939. Ten years' research experience in the field of human engineering in aviation, including vision, visibility, cockpit illumination, exterior lighting of aircraft, instrument lighting, hearing, speech intelligibility, anoxia fatigue, drugs, selection, crash analysis, in-flight and preflight feeding, and passenger comfort. Formerly college instructor; at present, Officer-in-Charge, Navy Lighting Projects. Desires position with an air line to develop a program of "Test and Evaluation," preferably in Department of Engineering Research and Development. Will advise engineering staff on human engineering and will test and evaluate equipment, present and proposed, with respect to efficiency of pilot and crew and to passenger comfort.

478. Aeronautical Engineer—Former Army pilot (all types) and engineering officer. Many years' experience in design, inspection, manufacture and test. Hydraulics and supercharger specialist. Broad knowledge of aerodynamics, thermodynamics, and design practice. Excellent engineering draftsman; holder of patents; many ideas for future development. Desires development work on engines or airplanes.

474. Aeronautical Engineer—B.S.Ae.E. degree, 26 years old, World War II veteran. Six months' experience as Fuel System Design Engineer with Air Technical Service Command, U.S.-A.A.F. Over three years' experience in the U.S. Air Corps as Flight Engineer and Maintenance Chief on heavy bombardment-type aircraft. Experienced in supervising groups. Desires a permanent design or layout position with aircraft manufacturer. Any location in the United States will be considered.

473. Administrative Engineer—B.A.E. Seven years' experience in airplane design (preliminary and production), research, shop work, factory liaison, and salvage work. Group Leader. Airplane and helicopter experience. Available as assistant to busy executive in general management or engineering; aircraft or allied field. New York area preferred but not essential.

471. Aeronautical Engineer—B.S. in Ae.E., 14 years' flying and 12 years' engineering experience including design problems, development of test and control devices, performance studies and conduct of airplane, power plant and accessory flight-test projects, seeks product-improvement position requiring design aptitude and test ability. Interests not restricted to aircraft field provided employer can benefit from aviation background.

470. Aircraft Power Plant Engineer—B.S. in M.E.; 12 years' in aviation with leading aircraft and engine manufacturer. During recent years in charge projects, including personnel, involving installation, operation, maintenance, and overhaul of aircraft powerplant equipment. Qualified to assume complete management of such projects. Wide acquaintance with key personnel airlines, aircraft manufacturers, distributors, service bases, A.A.F., and Navy Bureau of Aeronautics. Travel or live anywhere.

469. Chief or Assistant Chief Engineer—M.I.T. graduate, age 36, extensive background in research and development work and air transport engineering. Ex-Lieutenant Colonel A.A.F. Formerly Chief Aeronautical Engineer of large foreign air transport division handling all phases of aircraft engineering, maintenance, flight test, etc. Production engineering experience with A.A.F. Matériel Command at Wright Field. Heavy prewar experience in aircraft-engine development and testing. Desires position with good future leading to executive status. Location open; available immediately.

468. Expert Mechanical Design Engineer—Fifteen years' internal combustion engine design experience, including 3 years on diesel engines, 6 years on aircraft engines, last 2 years on high-temperature rotating machinery including gas-turbine aircraft auxiliary power plant. Interested in design supervision, engineering liaison, or sales engineering.

467. Aeronautical Engineer—Spanish-born and educated, author of English-Spanish aviation dictionary. Will undertake technical translations into European or Latin-American Spanish; books, brochures, advertising copy.

465. Aeronautical Engineer—Doctor of Aeronautical Engineering desires associate or assistant professorship in aeronautical department of university. Good teaching experience in aerodynamics and aircraft structures; several years in aviation industry on airplane design.

464. Tool Engineer—Aircraft and machine-shop experience; desires subcontracts for tool design, processing or special machinery.

454. Management Executive—Vice-president and general manager of engineering for consulting company doing war work seeks new connection. Twenty years' experience as executive in engineering, production, and general management. Specially qualified as an organizer and production consultant. Experienced major air-line executive.

453. Executive—Age 37, single, Protestant English-American. Fifteen years' continuous, well-rounded aircraft experience. Has experience in ground and flight instruction; airport and seaplane base management; airplane sales (sold over 50 aircraft prewar); charter and photographic; airline; manufacturing (inspector to factory manager); C.A.A. (inspector), quality control, engineering, research, and development. Was a key man with prime contractor (airframe) during the war (now reconverting to nonaeronautical product). Has valid commercial pilot, seven ground instructor, A. & E., radio operator and F.A.I. glider pilot certificates. Familiar with latest metal, plastic bonded wood, and composite aircraft techniques; also conventional, amphibious, and rotating wing aircraft. Desires position where knowledge, experience, initiative, and results are of prime importance. Last salary—$7,000.

447. Aeronautical Engineer—With own design of practical roadable airplane having basically new and desirable features seeks connection with aircraft manufacturer who has well-established manufacturing facilities but needs a product. M.I.T. Graduate with 10 years' sound aircraft engineering experience.

444. Aeronautical Engineer—Twenty-two years old. Has lived in Spanish-American country for 16 years. Writes and speaks Spanish and English fluently, thoroughly acquainted with Latin customs. Desires position in which engineering training and knowledge of Spanish and English would be of value, either in the United States or Latin America.

439. Engineer—Administrative Liaison—Aeronautical Administrative Engineer—Seven years' air-line operation maintenance experience with international air line and U.S. Naval Air Transport Service. Lieutenant Commander, Squadron and Staff Engineering Officer. B.S. in Mechanical Engineering (Aero Option), University of California. One year, Harvard Business School. Permanent position with international transportation concern desired. Available immediately.

436. Aeronautical Engineer—Fourteen years actively engaged in the aircraft industry, including project design, flight test, and development engineering, and as representative in procurement and field service. Thorough knowledge of maintenance and flight operation, including A. and E. licenses and 7 years' flight experience. Present affiliation with major aircraft company, entered in 1937. Desires permanent responsible position and opportunity for advancement, commensurate with ability, in development, sales or as technical representative. Geographical location unimportant. Four years of university work and graduate of two leading schools of aeronautics. Understands Spanish and French. Excellent commercial and military references.

435. Aeronautical Engineer—B.Ae.E., University of Minnesota. One year detail design and minor layout drafting. Over four years' service with Air Technical Service Command, U.S.A.A.F., as engineering officer. Military experience included one year of checking contractor-submitted stress analyses and the design and supervision of installation, in aircraft, of experimental equipment; three years as resident liaison engineer for A.A.F. at large West Coast aircraft manufacturer. Served three months in England and Germany with Air Technical Intelligence Section of U.S. Strategic Air Forces as technical investigator of German aircraft development. Desires permanent position with opportunity for advancement in technical or administrative engineering or allied field. Los Angeles area preferred. Available immediately.

353. Industrial Engineer—B.S.M.E. Eleven years' experience in selecting equipment and supervising installations for aircraft manufacturing processes, including experience in production of airplane motors; also 25 years' experience in the automotive engineering and production field. In a position to do consulting work as industrial engineer.

292. Manufacturing Executive—Mechanical Engineer with 26 years' experience in production management covering planning, procurement, tooling, procedures, precision machine-shop practice, production control, and inspection. Aircraft manufacture or kindred field.

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When the Very High Frequency network for communications between planes and ground is in full operation, the voice of the Nation's airlines will be clearer than ever before.

By early 1947 the country's airlines will have received approximately 1700 Western Electric "ARC-ONE" transmitter-receivers. This set is the Navy AN/ARC-1 of wartime fame. It is the direct result of Bell Telephone Laboratories-Western Electric pioneering in VHF aviation communications which started back in 1937.

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